

MECHANICS' MAGAZINE,

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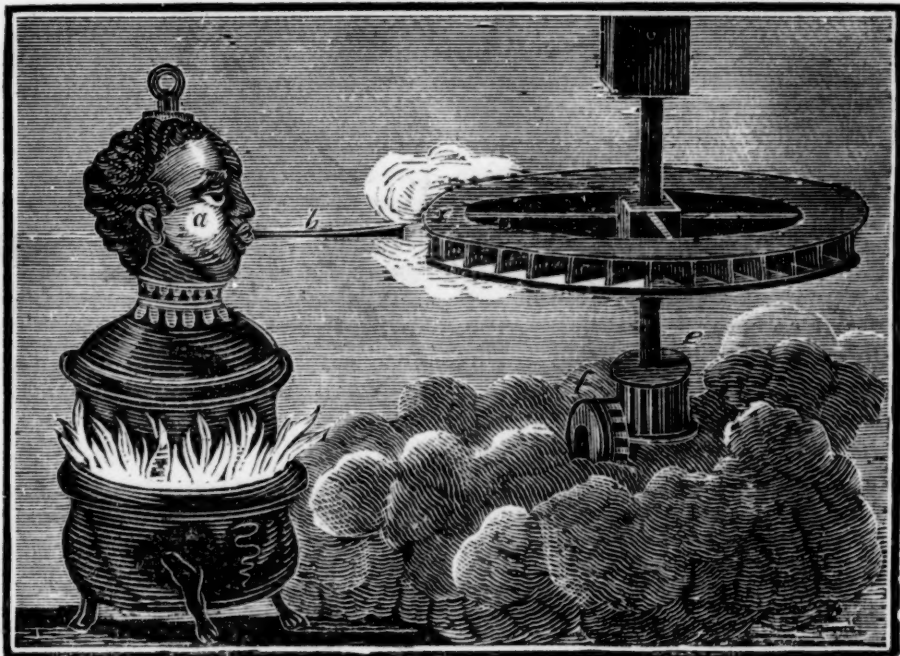
REGISTER OF INVENTIONS AND IMPROVEMENTS.

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—“Man was mark'd
A friend in his creation to himself,
And may with fit ambition conceive
The greatest blessings, and the highest honors,
Appointed for him, if he can achieve them
The right and noble way.”—MASSINGER.



FIRST APPLICATION OF THE POWER OF STEAM TO A USEFUL PRACTICAL PURPOSE.

—The first person in modern times who applied the expansive power of steam on any scale to a useful practical purpose, was Giovanni Branca, an eminent Italian mathematician, who resided at Rome in the beginning of the seventeenth century. His contrivance was an *œlipile*, from which steam issued upon a wheel formed with float-boards or vanes, like a water-wheel or wind-mill, and thus produced a rotatory movement. This wheel, by some intermediate mechanism, gave motion to the stampers of a mill for pounding drugs. The above figure is copied from that given by Branca to explain his invention; but it must be considered

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only as an ornamental and picturesque illustration of the principle by which he produced the moving power in his stamping-mill; not as a view of any part of the machinery which was actually constructed. *a* is a boiler in the shape of a negro's head. *b*, a pipe proceeding from it, which conducts the steam upon the vanes or boards of a wheel, *x*. Other wheels, *e*, *f*, are attached in the usual manner to communicate the motion in the required direction.*

It is on account of this contrivance that

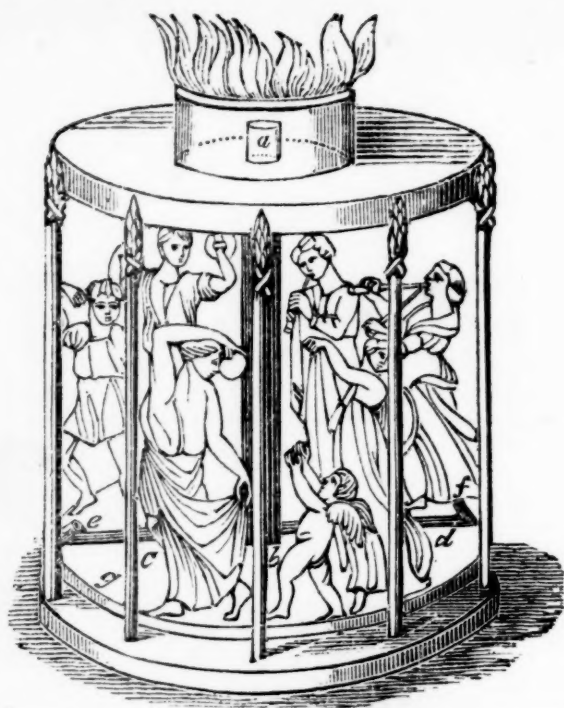
* Branca's account of his contrivance is contained in a folio volume of machines, which he dedicated in 1628 to a M. Cenci, Governor of Loreto. It was published at Rome in 1629, under the title of "Le Machine Diverse del Signior Giovanni Branca." Our engraving is contained in Plate XXV of that collection.

Branca is considered by his countrymen to be the inventor of the steam engine; and even in a recent English work* on this subject, he is allowed the merit of a *first idea*. To this he certainly has no claim; neither can his engine be compared with Hero's for its ingenuity, nor to De Caus's for its efficiency. Besides, long before this period, the same mechanism was described by Cardan, as moved by the "vapor from fire." And the mere substitution of steam by the Italian philosopher is not so original or important, as to give to the transition the rank of an invention. Branca was, however, a man of much ingenuity, and many of his machines are highly creditable to his abilities as a scientific mechanic.

The elasticity of the vapor of water, which had long been known to philosophers, but to them only, had now become familiar to water-work artists; and in their hands it was applied in a variety of ways to their favorite problem of raising water above its level in jets and fountains. Without vouching for the great effects said to be produced by these machines, we will describe two, as necessary to give a clear notion of the value of these conceits, and as specimens of the ingenious absurdities, which, under the name of *Air Engines*, were recommended even by experienced engineers about this period. The machines themselves, under another form, are to be found in the *Spiritualia*. The book from which they are extracted in their present shape was one of some reputation in its day, and many years after its publication it was thought worthy of being translated into English. The translation went through two editions.†—[Stuart.]

The engraving in the preceding page is one descriptive of the first *useful* application of steam. We shall now introduce to the notice of our readers a description of the first recorded observation of its application to produce motion, and although it must be considered as a mere toy, its introduction in our pages will, we hope, not be considered out of place.

FIRST APPLICATION OF STEAM POWER.—Although the elastic power of the vapor of water must have been familiar to man from the earliest period of his history, the first



recorded observation of the fact, and the application of steam to generate motion, appear to have been made by a Greek mechanic, about one hundred and thirty years before the Christian era.

Hero the Elder, who flourished at Alexandria in the reign of Ptolemy Philadelphus, was eminently distinguished in that age and region of refinement, not only for the extent of his attainments in the learning of the time, but also for the number and ingenuity of his mechanical inventions. In one of his books, he deduced all the laws of what are called the mechanical powers from the properties of the lever. His *Spiritualia*, or *Pneumatica*, contains the first account of the forcing pump: of a fountain, still known by his name, in which water is elevated in a jet by the elasticity of condensed air. Among other contrivances in the same treatise, he describes two machines of his invention; in one of which a rotatory motion is produced by the emission of heated air; and a similar movement is imparted to the other by the reaction of vapor rising from boiling water.

A pipe, *a*, is directed by Hero to be inserted under the hearth of an altar, on which a fire is burning. This pipe, placed in a vertical position, is moveable on a pivot, *b*, resting on the base of the altar. Two other pipes, *c*, *d*, of smaller diameter, proceed from the vertical one in a horizontal direction, having their extremities, *e*, *f*, open and turned upwards. A base or drum, *g*,

* Partington's Historical Account of the Steam Engine. London, 1822.

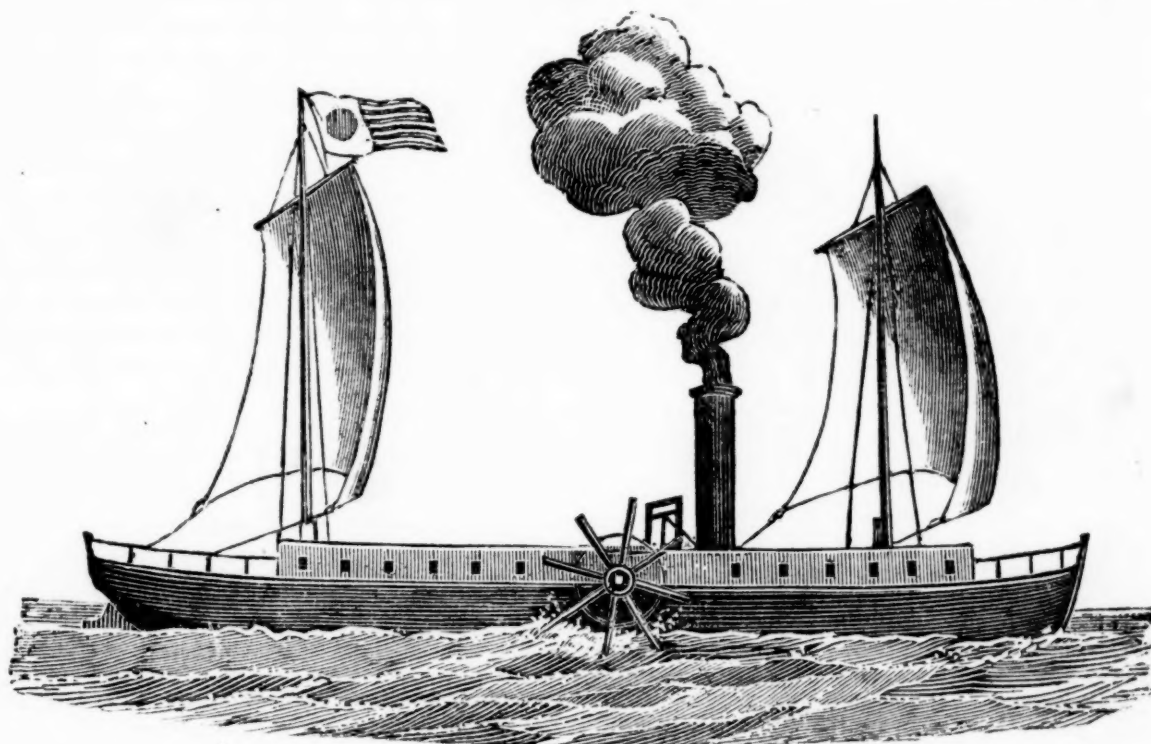
† "New and Useful Inventions for Water Works: a work both useful and delightful for all sorts of people; translated into English by John Leak." The plates appear to have been those used in the French edition.

is attached to the pipes, on which are placed small figures in various attitudes. The air at the upper extremity of the vertical pipe being heated by contact with the under side of the altar hearth, is expanded, and descends into the pipe, and proceeding along the horizontal arms is expanded, at their orifices, *e, f*. This causes them to revolve round the pivot *b*, so that the figures which are placed on the base *g*, are carried around with and appear "to lead the dance, as if they were animated beings."

It is scarcely necessary to notice the identity of this elegant apparatus with that of Barker's mill; and that the rotatory motion

would be produced, as stated by Hero, though not by the *emission* of warm, but through the *admission* of cold air at the orifices in the horizontal arms, in consequence of the rarefaction at the upper end of the vertical pipe under the hearth of the altar. —[Stuart.]

In addition to the foregoing descriptions of the "First Application of Steam," and the "First Useful Application of it," we now insert a cut of Mr. Fulton's first boat, (the *North River, or Clermont*), which we copy from a drawing made by himself, and which may be considered as descriptive of the *first successful application of steam in navigation*.



The following boats were built under the superintendence of Fulton, or according to his plan, during his life-time:

	Names.	Tonnage.	Where employed.
1806	North River, or Clermont	160	Hudson river
1807	Rariton	120	Rariton river
1807	Car of Neptune	295	Hudson river
1811	Paragon	331	Hudson river
1812	Fire-Fly	118	From New-York to Newburgh
1812	Jersey Ferry Boat	—	Ferry Company
1813	Richmond	370	Hudson river
1813	Washington	275	Potomac river
1813	York Ferry Boat	—	Ferry Company
1813	Nassau Ferry Boat	—	Brooklyn Company
1813	Fulton	327	Long Island Sound
1814	Fulton the First	2475	Navy Yard
1816	Olive Branch	—	Between New York & New Brunswick
1816	Emperor of Russia	330	Undetermined
1816	Chancellor Livingston	526	Hudson river.

For a description of Mr. Fulton's first trip, see page 173 of the first volume of this work.

Since the above was in type, Captain Davis Hunt, who was the commander of the boat, has seen the engraving, and pronounces it correct in every particular.

Sea-Serpent Harpoon. By MECHANICUS.
To the Editor of the Mechanics' Magazine.

SIR,—In these days of inventions and of sea-serpents, I deem it meritorious to contrive something for the destruction of such ugly looking monsters as have lately furnished such wonderment to the good people down east. Now, sir, if any of your readers should ever take a notion to go either whal-

ing or sea-serpentine, I would advise them to be provided with some half dozen of the machines of which I send you the drawings.

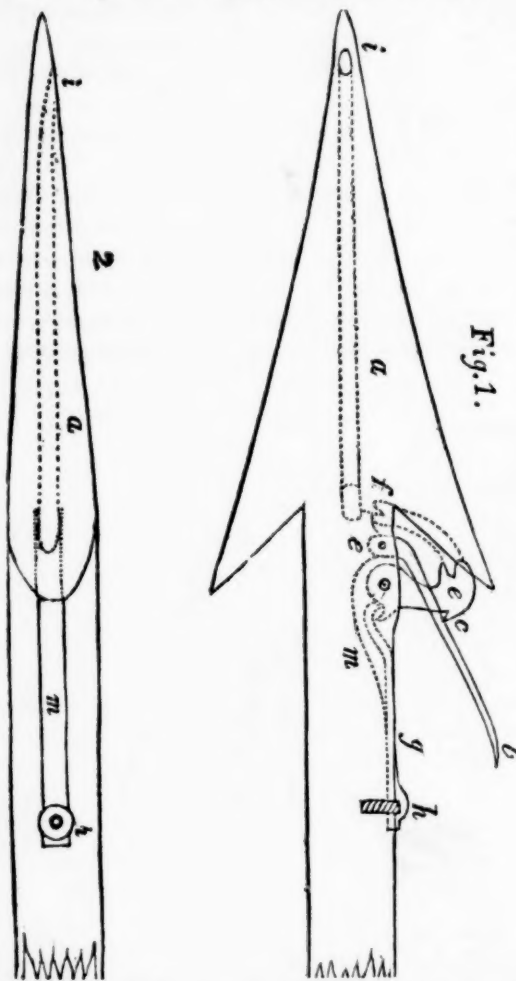


Fig. 1 is a harpoon with two barbs, and may be of any convenient size and length; *a* is a cavity drilled in from *i*, (which may be done with the point bent,) a little beyond the root of the barbs at *f*; a groove is cut in the shank under one of the barbs as shown at *m*, Figs. 1 and 2; in this groove is fitted the cock *e*, the main spring *g*, fastened by its screw *h*, and under the barb, at *f*, a percussion pin, or head, which communicates with the cavity *a*. A trigger with two prongs, between which the cock works, is set into two sockets at *o*, one on each side of the groove *m*, and fastened by a screw-pin, as shown in the figure; the trigger has a small hole in it, just above the space for the cock, for the point *c* to slip into to hold the cock back.

Now for the operation. A small charge of powder is put into the cavity, and over this a proper quantity of some poisonous substance, the effects of which shall be powerful and rapid; a percussion cap is put on the head, and the instrument is then cocked,

as shown at Fig. 1. The consequence of plunging such an instrument into a soft or fleshy substance must be obvious to any one, for as the flesh closes over the barb it strikes the end of the trigger at *b*, and throws the point of it down behind the head of the screw *h*, and by the consequent explosion of the powder the poison is forced into the body from the orifice *i*, and produces death at the same time that it fastens the object.

Now, sir, as I am the inventor, all I can say in praise of the invention is, that I should not like to be harpooned with such a machine.

MECHANICUS.

NEW PADDLE WHEEL.—A model of a newly invented paddle wheel for boats, which avoids the lifting of water, as in ordinary paddles, is now to be seen in the Hall of the Franklin Institute, Philadelphia. The inventors say that these paddles are brought into the water less obliquely than the common kind, and from the time they are vertical with the axis of the wheel retain a perpendicular position, until they are out of the water. This result is alleged to be the effect of a simple contrivance. The machine may be constructed of any requisite strength.

Reply to some Remarks made by Mr. Main and the Conductor on Mr. Perkins' Mode of Heating by Hot Water. By A. M. PERKINS, ESQ. [From Loudon's Gardener's Magazine.]

SIR,—I beg, without preface, to answer your correspondent, Mr. Main (p. 34), by stating certain facts.

The first objection which I shall notice is, that, in consequence of the extreme smallness of the tubes, and very small quantity of water, the apparatus cannot have that equality of heat so desirable during night, when the fire is most likely to be neglected.

I shall answer this objection by referring to the specification of my patent, which describes a furnace of fire brick, so constructed as to contain sufficient fuel for any specified time; and so capable of regulation, that the most equal temperature may be maintained for any number of hours required.

The apparatus which I first erected was at the villa of J. Horsley Palmer, Esq. at Fulham. This gentleman very liberally tried the first experiment on his own hot-house; and has, with equal liberality, allowed me to make use of his name to promote the spread of the invention, I, therefore, copy from his own memoranda,

which he gave me at the time, a table that shows how completely the equality of heat was maintained in the hot-house for eight days and nights. A Sixe's differential thermometer was set at nine o'clock every night, and examined at nine o'clock the following morning; the fire was also made up, and not touched during the twelve hours. The result was as follows:

1832.	Temperature in the open air.	Temperature in the hot-house.	Difference.
March 20,	47°	63°	16°
21,	45	63	18
22,	43	63	20
23,	38	63	25
24,	34	63	29
25,	38	63	25
26,	37	64	27
27,	38	65	27

Average difference 23 $\frac{3}{4}$

This table shows an average heat of about 23°; consuming in the 8 days only 12 bushels of cinders, which cost 11s. per chaldron, being 3s. 8d. for the eight days, or 5 $\frac{1}{2}$ d. for each 24 hours. Another experiment was made just previously to the above, and the following was the result: From the 4th of March to the 19th inclusive, being 16 days, the average heat was 23°, and 18 bushels of cinders were consumed, which is a fraction more than 4d. per day.

The second objection is that which you state yourself as likely to occur, viz. that after a time the tubes will become lined with deposit, and difficult to heat. This I can also prove to be erroneous, as far as it is applicable to my apparatus, from reason and fact. The reason that my apparatus is not likely to fill up is simply this: that its principle of being kept closed in all its parts, so that no evaporation can take place, is diametrically opposed to the cause of deposit. This is strongly exemplified when any portion of water escapes through an imperfect joint; for, if the tube be hot enough to evaporate the water, the deposit will be precipitated on the outside of the tube—showing clearly, that the lime or other matter that is in the water is held in solution until it escapes to the outside. In fact, we have circulated, for months, water completely saturated with salt, without any deposit being formed. Another fact, which I will state, will, perhaps, serve to remove your doubts, if any remain after the above explanation. I erected, in the show-room of Messrs. Ive and Burbidge, Fleet street, last winter, an apparatus, consisting of 150

feet of tubing, of the dimensions of only one fourth of an inch internal diameter, which has been at work ever since, without the least appearance of deterioration, either from oxidation, sediment, or otherwise. Were it necessary, I could mention many other instances; but I shall content myself with one.

One of Mr. Palmer's vineries contains an apparatus of 400 feet, of three quarter tubing, which was kept in operation last winter for the purpose of forcing grapes. At the end of the winter we opened it, and found that not a drop of water had evaporated or disappeared in any way; and, upon washing it out, the water was as clear as when put in. I should observe here that the apparatus was worked a few days before commencing to force; and that, then, all the oil and other matters, which necessarily adhere to the tubes during their manufacture, being taken up by the water, it was drawn off, and the pipes were washed out thoroughly by a common garden engine, in order that the experiment might be complete.

The third objection is, that the coil of tubes in the furnace, from their extreme smallness, must soon burn out; and the reason given is, that all tubular boilers, heretofore, have been liable to that objection. I will state the causes which occasion this effect, and then show why my apparatus is not liable to it.

The cause of the tubular boilers upon the evaporating and open-cistern systems burning out, is the want of some means of keeping the water in contact with the tubes which are exposed to the immediate action of the fire; for if the tubes have nothing but the weight of water and of the atmosphere to press upon them, the water will be driven out of the tubes by the superior tendency of the fire, when it burns with intensity, acting upon the tubes to repel it: and, thus, every time the fire is brisk, the tubes get red hot, and very soon burn out. Now, my invention directly meets this defective point; for, as the apparatus is closed in all its parts, no sudden heat can overpower the tendency of the water to circulate in contact with the tubes; for, if the heat is accelerated sufficiently to cause a tendency of the water to fly off, it meets with a reaction just equal to its action; and, therefore, it counteracts that tendency of the repellent power of heat in the same proportion. Thus, that which is a fatal objection to all tubular boilers with open reservoirs, is to my sys-

tem one of its greatest advantages; for it causes the heat to circulate more rapidly, and, consequently, to a greater distance, than can be done by any other system.

The fourth, and most serious objection, urged against my system, is the liability of the pipes to burst. This I will meet openly and fairly; and I think I can prove that it is less liable to serious accident than the open-cistern system, with a close boiler. I could mention a great number of facts respecting accidents from the open system; and one object of my improvement was to remedy such accidents. But one strong illustration, which I shall subjoin, will be sufficient to show that such an accident may occur even with an open cistern. I refer you to the letter of Mr. Carpmael, Patent Agent of the Patent Office, Lincoln's Inn. From this gentleman's letter, and the accompanying diagram, you will perceive how he exploded a boiler with an open reservoir, and the reason why it may and does often occur: the effect taking place upon the same principle on which low-pressure boilers are exploded. The means which my apparatus possesses of obviating this defect is the power I have of making the tubes strong enough to resist any possible pressure. For instance, the present tubes which I make are proved to bear 3000 lbs. to the square inch: and when it is considered that, to acquire 300 degrees of heat, it is only necessary to resist a pressure of 60 lbs. or 70 lbs. to the square inch, it must be evident that there is sufficient room allowed for any thing extraordinary in the way of pressure. All the care that is necessary to make my apparatus perfectly secure against such accidents is to prove it with a common hydraulic pump the last thing before setting it to work.

As some of my pipes have burst, and one, in particular, at the Guardian Fire Office, I think it right to explain how that occurred. When my apparatus was first erected in that office, which was last winter, the building was not finished; and the workmen being anxious to dry the walls of the new building, set the apparatus at work before it was proved; and as it is almost impossible, in 1000 feet of pipe, to make every thing perfect at first, so it was in this case; for, in giving the fire an unusual draught, the heat of the pipes was increased to an unprecedented extent, and the consequence was that a pipe split in one of the empty rooms,

and made a slit in the seam of the pipe about 8 inches long, and an eighth of an inch wide. Another pipe was immediately put in, and the apparatus proved; it has been at work ever since, to the perfect satisfaction of the committee.

This defect would be a serious evil, if I had not the means of remedying it by using stronger tubes, and having all my apparatus proved (previously to using) by the hydraulic press.

So confident am I now of the perfect safety of my apparatus, that I am ready to trust its erection to gardeners themselves; and have made arrangements for sending, to any part of the country, coils and tubes, with ample printed directions for erecting them, and managing them afterwards. This will reduce the cost of a hot-water apparatus to its minimum.

I am, sir, yours, &c. A. M. PERKINS.
London, Feb. 3, 1833.

On the Construction of Curves for Arches. By VAN DE GRAAFF. [From the American Railroad Journal.]

There is, perhaps, in the whole art of building, no subject which requires the exercise of more mathematical learning, than the construction of arches in equilibrio. And those who are unacquainted with the principles of statics, cannot but see with surprize the great deviation from a state of equilibrium produced by a small variation in the curvature of an arch. An example of this important fact may be given in the curves of a common and semi-cubical parabola: for to equilibrate the former, an uniform vertical pressure is required through the whole length, and yet, with regard to the latter, an infinite pressure is required at the crown to produce equilibrium. So great is the difference in the condition of equilibrium in those two curves; and hence is shown the importance of having judicious curvatures in the arches of aqueducts and bridges.

In the construction of flat arches the oval is usually taken as a substitute for the true ellipse; and, therefore, when such arches are equilibrated upon the supposition of an elliptical curve, it is necessary that the oval should coincide very nearly with it.

The ovals usually constructed with three centres are without the true semi-ellipse at the flanks, which are the weakest points; and they should, for that reason, not be used in the con-

struction of arches, unless the span be very small. However, as the use of three centres has the advantage of simplicity, and may do for small spans, I will give a method of describing such an oval, which will meet the true ellipse at the flanks, and differ less from it at all other points, than by the method now in common use. It is not necessary to give a detail of the whole investigation. Take the rise of the arch as unity, and let a denote the semi-transverse, R the radius of the smaller arc, whose centre is in the transverse, and R' that of the greater arc, whose centre is in the conjugate axis. Compute the value of R from the following cubic :

$$R^3 - R^2 \times \left\{ \frac{a^2+1}{a} + 1 \right\} + R \times \left\{ \frac{a^2+1}{2a} \right\}^2 + \frac{a^2+1}{a} + 1 \left\{ - \frac{a^2+1}{a} \right\} = 0;$$

And find the value of R' from the formula,

$$R' = R + \frac{R \times a - R \times \sqrt{a^2-1}}{2a - R \times \sqrt{a^2+1}}$$

Having obtained the values of R and R' , the position of the three centres will of course be given; and a straight line passing through those centres will give the meeting point of the arcs composing the required arch. A reference to the following table will save all the trouble of computation; it is calculated from the above expressions, and by taking proportional parts, it will serve for any span and height which may be required :

a	R	R'	a	R	R'
1.00	1.0000	1.0000	1.30	0.8304	1.5652
1.10	0.9347	1.1763	1.35	0.8085	1.6698
1.15	0.9057	1.2688	1.40	0.7879	1.7772
1.20	0.8788	1.3645	1.45	0.7685	1.8873
1.25	0.8538	1.4635	1.50	0.7500	2.0000

EXAMPLE: Let the span of an arch be 30 feet, and the rise 10 feet: to find the radii of curvature for three centres. Here, $a = \frac{15}{10} = 1.5$; and hence $10 \times .7500 = 7.5$ feet, and $10 \times 2.0000 = 20$ feet, are the radii required.

But it is to be observed, that an oval described with three centres can have no point giving a true normal to the elliptical curve, excepting the springing points and crown; and the same thing is true when five centres are used. The least number of centres which can be judiciously used in substituting an oval for an elliptical arch, is seven. Such an oval may have one point in each flank giving a true normal. With

eleven centres two normals may be obtained, and with fifteen centres three normals can be had, and so on for any number. There is no advantage in using the intermediate numbers 5, 9, 13, &c. The oval usually given with eleven centres contains no one point having a true normal to the elliptical curve, with the exceptions above mentioned.

By using seven centres with a correct normal in each flank, an oval will be had, which approaches so exceedingly near to the true ellipse that it may be very safely equilibrated for that curve. I have investigated several methods for determining the position of those centres, and the radii of curvature of the arcs. That which seems to be the most expeditious, is the following :

Let a denote the semi-transverse; b the semi-conjugate; m the given normal, whose position should be such as the eccentricity of the oval will require; p and q the corresponding co-ordinates, whose origin is at the vertex of the semi-transverse; n the sub-normal; f the angle formed by the curve and the ordinate q .

Put $k = \frac{m}{n} \times \sqrt{a-p-n}$, and $s = \frac{q}{n} \times \sqrt{a-p-n}$.

From known methods, the following expression for the angle f is readily obtained by taking radius unity :

$$\text{Tan. } f = \frac{p \cdot \sqrt{2a-p}}{q \cdot a-p}$$

Let e denote the complement of f ; and compute the values of two angles, z and u , from the following equations :

1st. To find z ,

$$m - \frac{2ab^2}{a^2+b^2} + \text{Cos. } z - \frac{n+p-m}{2 \sin \frac{1}{2} f} \times \frac{\text{Cos. } \frac{1}{2}(f+z)}{\sin \frac{1}{2} z} = 0;$$

2d. To find u ,

$$\frac{m+k-b-s}{2 \sin \frac{1}{2} e} \times \frac{\text{Cos. } \frac{1}{2}(e+u)}{\sin \frac{1}{2} u} - \frac{\frac{2ba^2}{a^2-b^2}}{\frac{a^2+b^2}{a^2-b^2} - \text{Cos. } u} + m + k = 0.$$

The formulas for the radii of curvature of the arcs are then the following :

$$1. R = \frac{\frac{2ab^2}{a^2-b^2}}{\frac{a^2+b^2}{a^2-b^2} + \text{Cos. } z}$$

$$2. R' = R + \frac{n}{p - R} \times \frac{\sin f}{\sin(f - z)}$$

$$3. R''' = \frac{\frac{2ba^2}{a^2 - b^2}}{\frac{a^2 + b^2}{a^2 - b^2} - \cos. u}$$

$$4. R'' = R''' - \frac{R''' - b - s}{\cos. (f + u)} \times \frac{\cos. f}{\cos. (f + u)}$$

In the above expressions, R denotes the radius of the arc whose centre is in the transverse axis of the arch; and the number of degrees in this arc is expressed by the angle z . The quantity R''' is the radius of the arc whose centre is in the conjugate axis produced if necessary; and the number of degrees in that arc is expressed by the angle $2u$. The radii R' and R'' belong to the two arcs whose centres are in the given normal produced; R' being the smaller, and R'' the greater. The number of degrees in the first of these two arcs will be expressed by $f - z$; and the second by $e - u$. This furnishes data for an easy computation of the whole length of the arch, and of each constituent arc.

When an arch is to be made with a view of sustaining the weight of a heavy embankment, it presents the following problem to those who direct the construction: To determine an arch which will be equilibrated with sufficient security by means of the superincumbent weight, and whose voussoirs may be cut normal to the curve without subjecting the workmen to needless liability to error from a complicated manner of construction. Supposing the road-way to be horizontal, or nearly so, the curve of strict mathematical equilibrium will be difficult to construct. I will, therefore, give a method of computing the ratio of the axes of an ellipsis, and their actual values, such that a segment will coincide with the arch of true equilibrium very nearly; and such a segment, being of easy practical construction, should always be preferred to the semi-circle under heavy embankments; for thus, much of the masonry usually required about such arches will be saved, and a more secure equilibrium obtained.

Let p denote the rise and q the half span of the required arch; h the height of embankment upon the crown; r the thickness of the arch, or length of the voussoirs; c the specific gravity of the embankment; c' the specific gra-

vity of the materials composing the arch. The following expressions for the values of the semi-axes of the required ellipse may then be had from an investigation conducted upon received principles of statics:

1st. To find the semi-transverse,

$$a = \frac{1}{3} p \times \frac{\left\{ \frac{c'.3r + p + 3ch}{3c'r + 3ch} \right\}^{\frac{1}{3}}}{\left\{ \frac{c'.3r + p + 3ch}{3c'r + 3ch} \right\}^{\frac{1}{3}} - 1};$$

2d. To find the semi-conjugate,

$$b = \frac{aq}{p.2a - p}^{\frac{1}{2}}$$

Hence is demonstrated the following

THEOREM: An arch of given rise and span having to sustain in equilibrio a given superincumbent weight with a horizontal top surface: I say, an ellipsis may always be found, of which the required arch will be a segment very nearly.

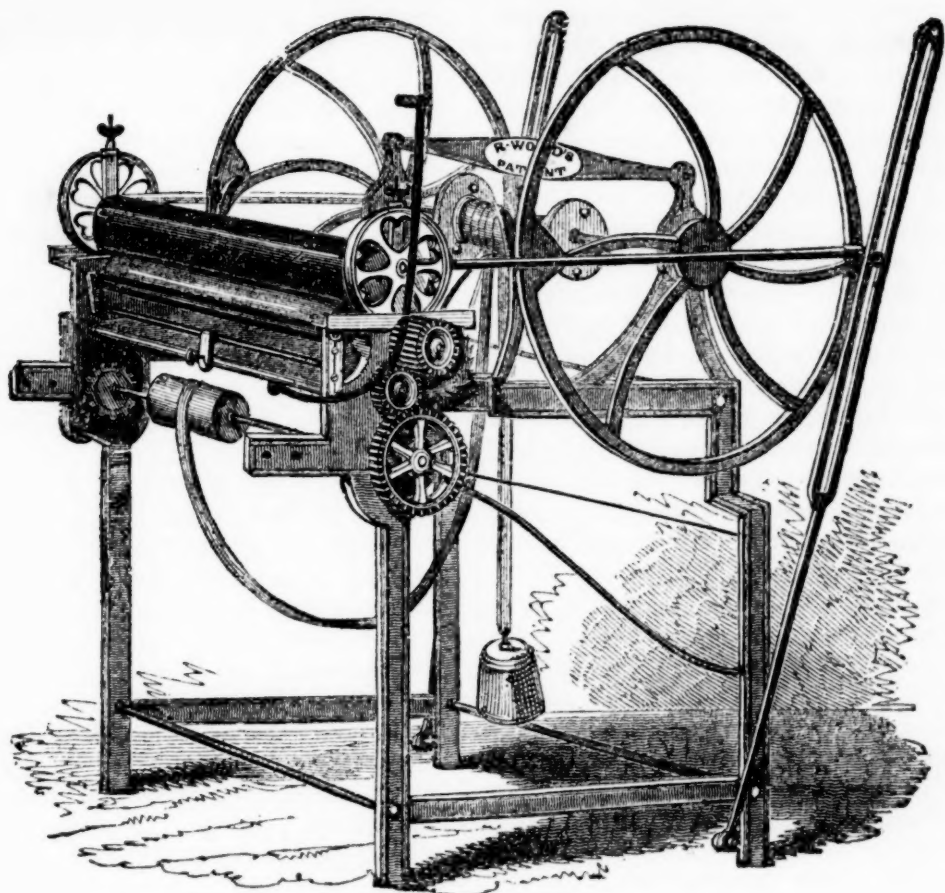
In the construction of aqueducts and bridges the segments of circles are frequently used for arches, without any regard to their equilibration. Such an arch would instantly fall when the centering is removed, if it were not for the adhesion of the cement and superincumbent matter. But an arch properly equilibrated, agreeably to the above theorem, will still have those advantages, and the work will, in consequence, be perfectly secure.

The method of tracing such an elliptical segment will be obvious from the preceding remarks. Two of the four formulas, marked 1, 2, 3, 4, will apply to this case when three centres only are used; the last two when the transverse axis is horizontal, and the first two when that axis is vertical. When seven centres are taken, one true normal may be introduced into each flank of the segment, and then the formulas just mentioned will give only two of the radii. The other two radii will in this case be different; but the investigation is not difficult, and I cannot pursue that subject further in the present number of this Journal.

The mathematical principles of inverted arches should be understood by practical men. A scientific article upon that subject, accompanied with plain practical results, and communicated to the public through the medium of this Journal, would, perhaps, be useful to those engaged in the construction of such works.

V. D. G.

Lexington, Ky., August 1, 1833.



Wood's Inking Machine. [From the American Journal of Science and Arts.]

Of all the inventions produced by the ingenuity of man, none has had so extensive and beneficial an influence as the Press; and any improvement in a machine so widely affecting the interests of society cannot be considered unimportant. Accordingly, the history of printing, from the rudely carved block and simple press of the inventor of the art, to the moveable types and complicated machinery of the present day, would be found at once curious and interesting. But, though a general view of the progress of this chief of arts could not be unacceptable, it is proposed, at present, merely to invite public attention to a machine which will perhaps be considered not one of the least important of its improvements.

It is well known that the increased demands made upon the press, by the eager thirst for knowledge, and the general spirit of competition, that characterize the times, have caused the power of steam to be called to its aid, to obtain despatch and cheapness of production. The steam press, however, though a proud trophy of modern art, from

its great size and enormous cost, could be used only in the greatest establishments, and by men of large capital; while, at the same time, the general inferiority of its work, which almost necessarily resulted from its great despatch, limited its use chiefly to the printing of newspapers. A machine was still wanting that should be available to the common printer, that would enable him to work at less cost, and to compete with his more opulent neighbor. This desideratum was attempted to be supplied by some contrivance that might be applied to the common hand-wrought printing press, in such a way as to cause it, by its own action, to ink the form of type by means of a roller, when worked by one man. Several attempts had been made for this purpose, both in this country and in Europe, but hitherto without success: the different machines being either too deficient in the proper distribution of the ink necessary to good work—occasioning too great an obstruction to the action of the press, to allow of its being worked by a single person—or requiring too great an alteration of its construction, to admit of general use.

In this machine these objections have

been overcome; and it is thought that it will be found to be well adapted to the purpose for which it is intended. It is applicable to any of the hand-wrought presses in common use; requires no additional motion on the part of the workman; and but a slight increase of muscular power.

The machine being placed on the side of the press opposite to that on which the workman stands, the axis of the handle of the press (called the rounce) is lengthened a few inches on that side, and a bevel-toothed wheel placed upon it, for the purpose of giving motion to the machine. This is the only alteration necessary to be made in the press; and except a couple of fastenings, attached to its frame to hold the machine firmly in apposition with it, is the only connection between them.

On the front side of the machine is a shaft, having at one end a bevel-toothed wheel, which is worked upon by that on the end of the rounce; in the middle, a barrel to which is attached a strap, which winds up a weight that propels the ink-roller; and at the other end a spur wheel, which gives the motion to the rollers, necessary for distributing the ink thereon.

Above this shaft, on a level with the form of type, is the distributing roller; upon the surface of which the ink is spread, and from which it is taken by the inking roller, which rests upon it.

The inking roller is supported by wheels at each end, upon which it travels; and is suspended in such a manner, that its pressure upon the type may be regulated with the greatest nicety. A large or small roller, or two small rollers, may be used if desired.

Behind the distributing roller is placed the ink fount or trough; in which is an accurately ground iron roller, revolving in the ink, which is allowed to flow upon its surface more or less freely, by means of an adjusting scraper.

Resting against the fount roller is a small supply roller, which, during the action of the machine, is raised against the distributing roller and communicates ink to it, which, by the assistance of another small roller on the opposite side, and of the inking roller on the top, is spread thereon of a perfectly even and uniform thickness; the distributing roller having a lateral or end motion, as well as a revolving motion, to make the distribution more complete. In this manner a much more perfect distribution is obtained than in machines in which the ink is directly com-

municated to the roller that passes over the type.

At the back part, on a horizontal axis, (having in the middle a moveable barrel, to which is suspended a weight, and to which is also fastened one end of the strap before mentioned, attached to the barrel on the shaft in front,) are two fly-wheels, of diameters corresponding with the width of the table of the press; having on the outer side of each a pivot that runs in a slot or groove in a perpendicular lever, that works on a joint at the bottom of the machine, and on the inner side a small projection, by which a catch holds the wheel in its proper position.

To these levers, at the height of the inking roller, are attached by joints horizontal arms, that extend to it; and which, by the vibratory motion given to the levers by the action of the fly-wheels, move it forward and backward over the form; and by properly proportioning the barrel on the axis of the fly-wheels, and that on the shaft in front, the roller may be made to traverse the form, once, twice, or oftener, as desired.

This description will give a tolerable good idea of the general construction of the machine, the operation of which is as follows:

The workman, in running in the table of the press, winds up the weight that propels the inking roller; and in running it out, gives the motion to the several rollers by which the ink is communicated to and distributed upon them.

The frame of the press on which the sheet of paper is placed, (called the tympan,) when raised, strikes a lever, which releases the catches that hold the fly-wheels, which are immediately set in motion by the weight on their axis, and, by their revolution, carry the inking roller forward and backward over the form.

A strap or string, attached to the same barrel to which the weight is suspended, but in an opposite direction, is wound up by its descent, and, at the proper time, raises a lever which throws the catches into their places, and arrests the motion of the wheels.

This machine, which has also been adopted in England, is thus noticed by the editor of the Repertory of Patent Inventions, published at London:

"Persons who have seen the grand roller cylinder presses, moving by the aid of a steam engine, and at the Atlas newspaper office in particular, must have been struck by the peculiar method of distributing the ink." After describing this method, he says

"now the objects gained by this series of rollers—saving of manual labor, expedition, and regular supply of ink,—are gained also by the invention under notice. The grand difference is in the *primum mobile*. In the case we have described, the mover power is steam; the space occupied is very large, and the expense exceedingly great; and we have found this invention applied only in the largest establishments, and to those immense rolling presses that steam alone can work.

"Here it is that Mr. Wood's merit begins. He has applied a system of rollers, as like as possible to those we have just described, to hand-wrought printing presses. The action of a part of the press is made to produce the rotation of a fly-wheel, which sets in motion the inking process, and its effect is exactly the same as this important part of the steam press, without its expense."

[We have witnessed with pleasure the operation of this machine at the establishment of the inventor in this city. It is so constructed as to be applied to any common printing press, and adds very little to the labor of the pressman. The distribution is sufficient for the largest and heaviest forms, and the quantity of ink taken may be regulated with great accuracy. The roller, passing four times over the form, produces a uniformity of color, and we think if it had no other recommendation than economy, it is worthy the attention of the proprietors of printing establishments.

Several printers of eminence have introduced it into their establishments, and pronounce it decidedly the best invention of its kind. Among them we instance the following, who are well known to be competent judges: Daniel Fanshaw, printer to the American Bible and Tract Societies, Geo. P. Scott & Co., printers of the New-York Mirror, Mahlon Day, printer of the New-York Price Current, Munroe & Francis, Boston, Hezekiah How & Co., New-Haven, Philemon Canfield, Hartford, William H. Niles, Middletown.—ED. MECH. MAG.]

AMERICAN IRON.—It has been a study much attended to of late, to know the character of American and foreign iron, compared with each other.

The consumption of iron in the shape of boiler plates, and cast rails, is becoming enormous. The tenacity and character of the metal are yet to be thoroughly understood. The Baltimore iron is considered the best in the world for steamboats. As

yet we do not fabricate wrought iron rails, but probably very soon shall, as machinery will be contrived to equalize the difference between the prices of American and English iron. Cast iron rails have been made with success at our own furnaces.

The American iron being melted by the heat of charcoal is allowed to be more tenacious than the English, which is melted by coke.

To put the matter completely at rest, however, very interesting experiments have been made at the apartments of the Franklin Institute, under the direction of Mr. Johnson, a scientific gentleman. The Secretary of the Treasury was authorized some years since, by an act of Congress, to expend a certain amount in constructing machines to make experiments on the tenacity of iron and other metals used in steam boilers. It was so constructed as to admit any degree of temperature up to 500 degrees Fahrenheit.

Some interesting results have thus been obtained. The Pennsylvanian, who is our authority for the assertion, says it is ascertained that the tenacity of good iron is *increased* by the application of any degree of heat under 450 degrees, which is contrary to previous entertained opinions. Some Tennessee iron (from the Cumberland works) was found equal to a resistance of from 59,000 to 64,000 pounds the square inch! The Pennsylvania and Connecticut iron exhibited the same qualities. No iron from our state was sent on for trial. We hope some of our proprietors of forges will not forget to submit specimens of their iron to the test of these experiments.

It was also found that common American iron was better than the best British, and the best American equal, and generally superior, to Swedish and Russian.—[Albany Daily Advertiser.]

PATENT TINNED LEAD PIPES.—An article under this name is mentioned in the London papers, which seems likely to supercede the use of all other metals which hitherto have been employed for conduits. To lead alone, in pipes, cisterns, &c. it is well known that the most serious objections exist. For instance, the action of air on lead produces oxide, which water dissolves, and thus water becomes poisonous. Similar deleterious effects are caused by leaden pipes in beer engines. It was to remedy these evils that the new process of tinning lead pipes was brought to perfection, and Messrs. J. & R.

Warner, the patentees, affirm that the additional cost for the improved article is very trifling.

Pressure of Water at Great Depths in the Ocean. [From the American Journal of Science and Arts.]

Extract of a letter to the editor, from Prof. Lardner Vanuxem, dated Ship Virginia, of New-York, for La Vera Cruz, January 11, 1828. Latitude, $28^{\circ} 56'$, longitude, $73^{\circ} 16'$.

Dear Sir,—I wish to call your attention to two experiments made this day, which may not only interest yourself, but likewise some of the readers of your valuable journal.

Doubtless you are well aware of the numerous popular experiments, which have been made at sea, by lowering *empty* bottles well *corked*, to the depth of one hundred or more fathoms; such bottles, be the mode in which the corks have been secured what it may, do invariably, as the experimenters have stated, come up full of water; one instance, however, was related to me, in which a portion of air still remained, or, in other words, the bottle was not quite filled with water. In most instances the corks were thrust into the inside; in some, no change was observable. Experiments have been likewise made by well corking a bottle of fresh water, and lowering it into the sea, and, on examination, the fresh water was found to be replaced by salt water.

Being convinced that the presence of water in these popular experiments arose from the corks being forced into the bottles by the pressure of the water in some instances, and from the permeability of most corks, if not all of them, to water when so greatly compressed, in others, I was determined, before I went to sea, to prepare a bottle which would prove the correctness of the opinion just stated.

I had the top of the mouth of a strong porter bottle ground so as to fit a thick piece of glass equally well ground; the two surfaces being made as parallel to each other as could be obtained by grinding, as well as by rubbing the one upon the other. (The surfaces were not polished, as ought to have been done, to produce the most perfect contact possible.) A cork was first put into the bottle, using great force, and the top then covered with tallow, likewise the ground part of the bottle; and upon the two, the piece of glass was placed, then closely pressed to the bottle, and there properly secured by strong strings: grooves having been cut

into the piece of glass, so as to secure it to the neck of the bottle.

The bottle was then fixed securely to a *sounding line*, to which also a second bottle, prepared in the ordinary manner, was attached. This bottle was provided with a good cork, much larger than the mouth of the bottle, for it projected considerably over it, great force having been used to make it enter.

The log with its bottles was then cast into the sea, (there being a calm,) and one hundred and ten fathoms of line let out. After being down a few minutes, the line was drawn in, and the bottles examined. The bottle secured in the common way was full of water, the cork having been driven in, being in the lower part of the neck of the bottle. The other bottle exhibited no visible change, all things remaining as they were before being put into the ocean, with the exception of about a dozen drops of water, which must have passed, from the circumstances related, between the piece of glass and the mouth of the bottle, penetrating the tallow and the cork.

That water should find its way through cork, when subjected to a pressure of six hundred and sixty perpendicular feet of water, does not appear extraordinary, when we reflect that many kinds of wood are permeable to mercury, when acted upon by a pressure not so great as that of our atmosphere, as in the common experiment of the air pump: mercury being placed on a *piece of wood*, (its fibres being vertical,) covering the top of the receiver.

The instances related of bottles containing fresh water having their contents replaced by salt water, are owing to the same principle as the replacing of the *air of the bottles* by sea water; for fresh water being of less density than salt water, it would pass out, to make way for a denser fluid, or the same kind of fluid made denser by saline substances. It is my intention to repeat this experiment during the next calm, should one occur.

The most simple mode of trying the experiment which I made, would have been with a bottle whose mouth was hermetically sealed. The want of time before I left New-York prevented me from having one prepared.

NEW INVENTION.—A gum elastic cloak, lined with silk, has been invented in Baltimore. It is intended to be thrown over the shoulders in wet weather, and will effectually

ally shield the person and clothes of the wearer. When not wanted, it can be folded up into a very small bulk, and, on this account, must be found very useful and convenient. We mean to have one ordered on for our own use, so as to be ready for the next fall elections.—[Cin. Rep.]

WONDERFUL INVENTION.—A watchmaker of the name of Buschmann, living at Elsenburg, not far from Attenburg, in Saxony, has contrived a piece of machinery, which, without the assistance of steam, has been found strong enough to move a heavily laden wagon, placed in a fresh ploughed field, with the greatest ease, although sixteen horses could not stir it. The machine may be easily handled, and the vehicle moved by it most safely managed. The inventor has been offered \$200,000 for the secret; but as he had obtained patents from all the principal German governments, he has refused all offers.—[Danville Reporter.]

FACTS.—There are in the United States 1,000,000 of children and youth, between the years of 5 and 15, who are not in any school, and who have not any means of instruction. There are in the State of New-York 80,000 children, who are not receiving even a common school education—50,000 young men, unable to read, are yearly among the number of voters who go to our polls. One third of the inmates of our juvenile prisons and of our penitentiaries are, when committed, ignorant of their letters, and one half of them are not able to read.

CONSCIENCE.—Had God been an unrighteous being himself, would he have given to this,—the obviously superior faculty in man,—an authoritative voice on the side of righteousness? Would he have so constructed the creatures of our species as to have planted in every breast a reclaiming witness against himself? Would he have thus inscribed on the tablet of every heart the sentence of his own condemnation: and is not this just as unlikely as that he should have inscribed it in legible characters on the forehead of each individual? Would he have so fashioned the workmanship of his own hands; or, if a God of cruelty, injustice, and falsehood, would he have placed in the station of master and judge that faculty which, felt to be the highest in our nature, would prompt a generous and high-minded revolt of all our sentiments against the being

who formed us? From a God possessed of such characteristics, we should surely have expected a different-moulded humanity; or in other words, from the testimonies on the side of all righteousness, given by the vicergerent within the heart, do we infer the righteousness of the Sovereign who placed it there.—[Dr. Chalmers.]

METHOD OF OBTAINING CREAM FROM MILK.—A process of divesting the milk of its component portion of cream, to an extent hitherto unattainable, has been effected by Mr. George Carter, of Nottingham Lodge, and is thus detailed by that gentleman, in a paper presented to the Society of Arts:—A peculiar process of extracting cream has long been known and practised in Devonshire; this produce of the dairies of that county being well known to every one by the name of “clotted,” or “clouted cream.” As there is no peculiarity in the milk from which this fluid is extracted, it has been frequently a matter of surprise, that the process has not been adopted in other parts of the kingdom. A four sided vessel is formed of zinc plates, twelve inches long, eight inches wide, and six inches deep, with a false bottom, at one half the depth. The only communication with the lower compartment is by the lip, through which it may be filled or emptied. Having first placed at the bottom of the upper compartment a plate of perforated zinc, the area of which is equal to that of the false bottom, a gallon (or any given quantity) of milk is poured (immediately when drawn from the cow) into it, and must remain there at rest for twelve hours; an equal quantity of boiling water must then be poured into the lower compartment, through the lip; it is then permitted to stand twelve hours more, (*i. e.* twenty-four hours altogether,) when the cream will be found perfect, and of such consistence that the whole may be lifted off by the finger and thumb. It is, however, more effectually removed by gently raising the plate of perforated zinc from the bottom, by the ringed handles, by which means the whole of the cream is lifted off in a sheet, without re-mixing any of it with the milk below. With this apparatus, I have instituted a series of experiments, and as a mean of twelve successive ones, I obtained the following results: four gallons of milk, treated as above, produced in twenty-four hours four and a half pints of clotted cream, which, after churning only fifteen minutes, gave forty ounces of butter; four gallons of milk treat-

ed in the common mode, in earthen ware pans, and standing forty-eight hours, produced four pints of cream, which, after churning ninety minutes, gave thirty-six ounces of butter. The increase in the quantity of cream, therefore, is twelve and a half per cent., and of the butter upwards of eleven per cent. The experimental farmer will instantly perceive the advantages accruing from its adoption, and probably his attention to the subject may produce greater results. I shall feel richly rewarded, if, by exciting an interest on the subject, I can produce any the slightest improvement in the quality or mode of producing an article which may properly be deemed one of the necessities of life.—[Repertory of Patent Inventions.]

WANT OF OBSERVATION.—In matters connected with the earth itself, the want of common observation, and the loss occasioned by that want, are still more striking. If coal, or iron, or any other useful mineral, is found for the first time in any district, it will, in general, be found that the discoverer is not a native, but some stranger. There is a case in point. The greenstone rocks, which form a considerable portion of the lower valley of the Tay, contain vast numbers of veined agates or Scotch pebbles, and in some places the rock has, to a considerable depth, crumbled into mould, well fitted for agricultural purposes: but the pebbles, containing less clay than the stone in which they have been formed, and being of a close texture, do not decompose so readily. In consequence, there are whole fields and farms, where, excepting where the ground has been opened for quarries, every stone that can be picked up is an agate, just as in the chalk districts of England every stone that can be picked up is a flint. Some years ago those pebbles were fashionable, if not valuable, (and except in durability, size, or some use in the arts, fashion forms much of the value of any stone,) and they were consequently esteemed. The proprietor of one of the estates, on which there is really nothing but pebbles, was in London on some business; and as he did not often visit the metropolis, he resolved to purchase some trinket for his wife, as a memorial of his journey. He went to a jeweller's, and was shown all the varieties of gems and pastes, but he rejected most of them on account of their smallness, and made his election of a necklace, &c. of large and strongly marked Scotch pebbles. So much did he admire these, that he began to question the

jeweller (who was also a lapidary) what part of the world was so rich as to furnish jewels so splendid. With utter astonishment he heard the name of his own estate as the place where, in one day each season, a sufficient supply had been collected, during the time that the stones had been in fashion. The owner of the mine of so much beauty, and as it appeared to him, from the price that he had paid, of so much wealth, would have been glad to exchange his purchase for something that he could not get at home; but still he was pleased that the mine was his freehold. Home he returned; the present from London was duly seen and admired; and the very next morning, taking his mole-staff with him as a divining rod, he was early at his rhabdomancy. Three days he consumed in diligent and laborious search, keeping the secret of his wealth with great care, until he should astonish the world with its amount. In the course of his labor he picked up many stones, but, as they were all very rough and unpromising to look at, he cast away as fast as he gathered, till the third day and his patience were nearly at a close together. When he had nearly reached his home, he took up one of those nodules of which he had previously taken up and thrown down so many, and dashed it upon the rock with all his force, as if in vengeance for the deception which he had practised on himself. The stone broke in pieces, and in the fractures he found the colors, but not the lustre, of those disks which had so pleased him in London. He soon began to reflect that his uncut pebbles were not saleable trinkets, any more than the soil of his farm was saleable quarters of wheat; so he prudently resolved to follow his farming, and leave the pebbles to the lapidary, as before. The purchase, too, retained its value, as the pebbles that were collected from the fields as an incumbrance, and used in paving the court and filling drains, could not rival it; and he even boasted that the trinkets were the produce of his own estate, and spoke with admiration of the art and skill of the Londoners, who could make a few ounces of that, which was not worth sixpence a ton where it was found, worth several pounds in the market.

That is a homely anecdote, but it is a useful one, as it points out one of the reasons why those whom we would, without reflection, think should study natural substances the most, yet actually study them the least. It shows, too, that that is especially the case with minerals. The occupation of the peo-

ple of any district runs in a train ; those who are not required for the working of that train migrate to other places ; and if any one betakes himself to the study of nature, he is branded as an idler, or wizard, according as the current of popular feeling sets,—and whether it set the one way or the other, he is equally certain to be ejected from the companionship of the district, and must either associate with those at a distance, or be idler in reality.—[Mudie.]

LIME.—This is a simple mineral, or a letter in the geological alphabet, and a rock scattered very extensively and in vast deposits over the face of the globe.

Lime appears under a greater variety of color, texture and form, than any other rock. There are probably two hundred varieties of marble, all, or nearly all of which, are lime. Chalk, with the endless and boundless deposits of the more common limestone, is composed of the same elements. It crystallizes into numerous forms. Calcareous spar, with rhombic sides, is one form ; a six sided prism is another ; and several others might be named.

Lime exists in exhaustless abundance in almost every country. In many places it is the most common and almost the only rock.

No rock perhaps differs so much in its age, or in the periods in which the different deposits were formed. The oldest limestone was formed before the most recent granite. The most recent deposits are at this time accumulating ; so that the formation of limestone has been constantly going on for nearly six thousand years at least, consequently some specimens are about six thousand years old, and perhaps much more, while others have not completed their first year.

The uses of lime are very numerous and very important. In many places it is the common and only material for the walls of houses, the enclosures of farms, &c., and in every place is esteemed for the finest architectural work. It is the most common material for statuary work, and carving of various kinds.

For the interior walls of houses, or for plastering rooms, &c., it is nearly indispensable. Some specimens are of great value for water cements, as they cement the masses of stone in a wall so as to be water tight, and even grow hard under water. This is called hydraulic, or water lime.

Lime when burned has something of an alkaline property, like potash or soda, and is

used as a substitute for them. It is used as a flux, or an aid in melting, in the manufacture of the coarser kinds of glass, and in the smelting of iron. It is also used as a medicine.

Upon soils which do not contain a portion of lime, it is a valuable manure. It may be burnt and slacked, or pulverized otherwise, and applied to the land. Marl, which is lime commonly mixed with clay and sand, owes its value as a manure to the lime it contains.

The simple elements of lime are fewer in number than those of the rocks before named. The only elements which compose pure limestone, are oxygen, calcium, carbon, and usually a little hydrogen. Burnt lime is little else than oxygen and calcium ; lime in the quarry has oxygen and carbon, or carbonic acid with a little water, or oxygen and hydrogen are added. In the process of burning lime, the carbonic acid and water are driven off, so as to reduce it from a carbonate and hydrate to pure lime, which is oxygen and a metal called calcium.

The BURMAN BOOKS are mostly made from slips of Palmyra leaf, about three inches wide and a foot long, a number of which being fastened together are tied between two thin japanned boards of the same dimensions, which constitute the bindings.

The Burman character is formed of circles and segments of circles, closely connected ; the letters are written from left to right, and are remarkably clear and distinct ; they are formed with a sharp pointed instrument, resembling the ancient stylus, with which the letters are engraved on the Palmyra leaf ; but this style of writing is peculiar to the Burman language. The Pali character is totally different from the Burman, the letters being square and angular ; and in writing, much more trouble is taken with it than with the former. The books are generally composed of thin leaves, made with the bark of the bamboo, cut into very delicate stripes, and then plaited together. They are covered with varnish, so as to be completely smooth, and are not unfrequently gilt, and the characters japanned in black. The binding and margin of the leaves are richly ornamented with devices and grotesque figures, neatly executed with japan ; and I have seen the Pali books formed of leaves of silver, copper, and ivory—the latter, particularly, are very beautiful.

Letters are written with a stylus, on the Palmyra leaf ; and being then rolled up in a

circular form, are bound round with tape, and sealed.—[Crawford's Travels.]

MECHANICS.—The Beaver Republican contains the following article :

"There is a strange dislike to the name of mechanic in this country, as well as elsewhere : it would almost seem a disgrace to be an industrious or useful man. Each parent thinks his child superior in intellectual capacity, and capable of filling any station, whatever his ability to qualify him therefor. Hence we meet with professional men who would doubtless make most excellent mechanics, but, unfit for a profession, they remain all their lives in obscurity and poverty. Why is this? Have not the world yet learned to judge men by their actions, and not by the business they pursue? Look through the pages of history—whose names are the brightest?—who have been the benefactors of mankind? Why do we so often find men, of sound judgment in all things else, yielding to the dictates of pride and prejudice, and preferring that their children should be brought up in idleness, rather than give them such an occupation as would enable them to become useful to themselves and others."

Remarks on the above.—We are glad to see such doctrines. They are of more importance to the country, and the world, than men are generally aware of.

That parents should seek to place their children in those occupations which promise the greater freedom from toil, is, perhaps, the dictate of natural affection. What we love, we are pained to see engaged in laborious duty. But it is, after all, a mistaken view. It is not to be doubted that habit can render any occupation, if not agreeable, yet free from toil. The smith, whose anvil resounds with the hammer, the carpenter, the ship-builder, the artizan, are all of them happier than the man who has no employment. But this is not all. How few of those, who are assigned to what are called the learned professions, ever attain to either distinction or usefulness—and of the vast number that hang on the rear of the bar, like

"Lethe's sable cloud in the western horizon," and of those again who have engaged in the delicate and responsible art of healing the sick, or of those who fill the sacred desk,—how many, we ask, ever confer benefits upon either themselves or their country.

But again. The great object of the parent is frustrated—that is, the happiness of the child. The very contrary is ministered to.

The question is one of absolute idleness and comparative labor. Idleness none will commend. It is the rust of the soul—the faithful mother of misery and vice—the foul pool in which all that is disgusting and hateful is engendered—the Lazaar house—the very place of disease and corruption. Cowper personifies an idler thus—he is

—"A clock, that wants both hands,
As useless when he goes as when he stands."

Again :

"Absence of occupation is not rest,
A mind quite vacant is a mind distress'd."

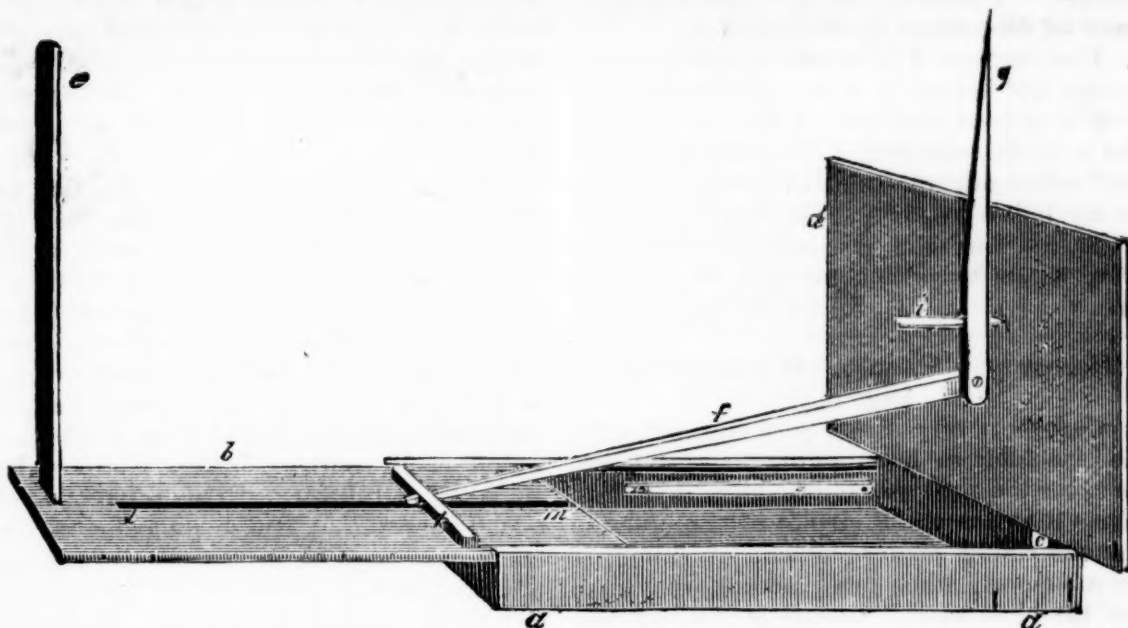
And yet how many parents are there who bring up their children in *idleness*! And yet they will tell you, "*we love our children.*" Nothing surely can be more paradoxical.

Such as see the evil of idleness, seek to avoid the tax that it pays, by finding some employment; but it must come as near to idleness as possible, since labor of any kind is supposed to be afflictive. Hence we see agriculture and the mechanic arts avoided; and any and every place sought after, rather than the virtuous—healthful—useful—honorable employment of the agriculturist or the mechanic!

And then comes in our distinctions in society, based on this frivolous and sickly feeling of attachment for our children. A mechanic, because he gets "his bread by the sweat of his brow," is not considered as good as a man who is too proud to labor, and who goes about "picking clean teeth," having nothing to eat, and wearing, perhaps, a fashionable coat, which, when he bought, he never meant to pay for; and giving, in his very gait and looks, proof of his blood—and will sometimes go so far as to speak of its richness and purity, and to thank God that he is not like other men—*these mechanics*!

Such a state of society is not a wholesome one. It betokens decay. It indicates that the pillars on which rest the fabric of our Government, and the temple of our liberty, and the social relations, are in a tottering state, and unless they are sustained by something more philosophical and practical, they will fall.

Away, then, with this sickly sensibility—this worse than canine madness. Let parents look to the subject. Let them bear in mind that Paul the Apostle was a Tent-maker, and that Benjamin Franklin was a Printer; and that from the work-shop have gone, in all ages, to the Senate-house and to the field, some of the greatest and best men the world has ever known.—[Phil. Com. Herald.]



Machine for making Drawings of Landscapes. [Communicated by G. LANSING, for the Mechanics' Magazine.]

DEAR SIR—I enclose you a drawing of a little machine I have invented for making drawings of landscapes, buildings, machinery, &c., of which the following is a description: *a a* is a box, say nine inches long, three wide, and three quarters of an inch deep, in every way similar to a water color box; *b* is the lid, or top, made to slide in or out at pleasure.

On the inside of the box, towards the left of the drawing, are screwed two supports, *c c*, which can be raised up or turned down; these are to be turned up when in use, to support the drawing-board (to which the paper is fixed) in a vertical position. On the end of the slide is placed an upright piece, half as high again as the drawing board, *d*, near the top of which is a small hole, *e*, for the eye to look through.

The next thing to be described is the apparatus for drawing, which is made of two pieces of wood, *f g*, say 12 or 13 inches long—*f* to be three-quarters of an inch wide, and one-quarter thick; *g* the same width, but thicker, lapping together at *h*, and fastened by a small screw, thereby forming a joint, that must work easy, but true. The piece *g* is brought to a point at the top, and also to an edge on the side, towards *d*, and has at the lower end, two and a half inches from the bottom, a hole to admit a pencil, *i*.

On the piece *f* is a cross bar, *k*, of lead, three inches long, and weighing three or four

ounces—it having a pin on the under side, working very loosely in a slit, *l m*, in the lid or slide of the box, the object of which is to keep the point, *g*, in a vertical position.

In using this machine, (supposing the drawing-board to be a foot wide,) the eye must be at least ten and a half inches from the board, *d*; for if it be nearer, the boundary of view at the sides will subtend an angle too large for the eye to take in without straining, and will cause the outward parts of the drawing to have a disagreeable appearance. To avoid this, it will be necessary to draw the slide *b*, till it be fourteen and a half inches from *d*, and the whole view above *d* will not subtend an angle above forty-five degrees, which will give a more pleasing view to the eye and picture.

Whatever width you intend your picture to be, the distance from the eye should be in proportion—as twelve is to the width, so fourteen and a half to the distance from the eye.

Now, having adjusted the machine as above, you will begin by placing your eye at the hole *e*; take hold of the pencil, and bring the point of *g* to that part of the object where you wish to begin, (which will seem to touch the object itself); gently pressing the pencil, *g*, against the board, *d*, follow the outline of the distant object with the point, *g*, and you will find a correct outline on the paper fixed on *d*. The piece containing the eye-hole should be made to take out, when not in use, and inclosed in the box with the rest of the apparatus, when it may be carried in the

pocket. A portfolio, or the cover of a book, may be substituted for the board *d*.

This machine I have had in use for some years, and believe it to be entirely original—it is at least with me. I have not applied for a patent, nor shall I. I shall think myself sufficiently rewarded in finding it of use to my fellow artists and mechanics.

Should you think it worthy of a place in your useful Magazine, you will oblige yours,
&c. G. LANSING, Engraver.

History of Chemistry. [Continued from page 6.]

Carbon is very fixed, perfectly, infusible, and insoluble in heat, and passes, with justice, for the most refractory body in nature. Thus it is frequently employed as a crucible for containing matters difficult of fusion, or as a support, when many bodies are treated by the blow-pipe. As carbon is a bad conductor of heat, it is used with success to line crucibles, to coat furnaces, and confine the heat, the infusible property of this body accompanies the property of not conducting caloric. In many of the arts this property becomes of the greatest utility.

When the temperature of charcoal is raised to ignition, and is then placed in contact with oxygen gas, the carbon burns with activity, sparkling, and slightly brilliant, but very sensible flame. It quickly disappears, becomes fused in the oxygen gas, and consequently assumes the fluid elastic form. It is found, that twenty-eight parts of carbon thus disappears, and unites with seventy-two parts of oxygen gas, and that there results from this combustion a new gas, which occupies less space than the oxygen gas, but its specific weight is almost double. This gas received the name of *carbonic acid*, as already mentioned, and will be treated of under that head.

What happens when charcoal is burned in a given quantity of common air, or when that air is not renewed, may be now understood. The ignited carbon combines gradually with the oxygen gas of the atmosphere, and becomes dissolved in such a manner as to lose its visible mass, and only to leave a few atoms of its ashes.

The air thus vitiated and really destroyed, as to its vital and respirable parts, by this combustion, produces very fatal accidents. It will be also seen that other circumstances, relative to charcoal, also augment its danger.

Carbon unites with all the simple combustibles, and with azote, or nitrogen; with sul-

phur, it forms a curious limpid liquid, called carburet of sulphur, or sulphuret of carbon*; with phosphorus, it forms a compound whose properties are but imperfectly ascertained; with azote, it forms cyanogen or prussic acid gas.

There exists so marked an attraction between carbon and hydrogen, that the compound (which is named carbonated hydrogen, or carburetted hydrogen,) is frequently met with among vegetable compounds.† But, besides this attraction of the *radicals*, hydrogen gas may easily hold in solution a greater or less quantity of carbon, which happens whenever it is disengaged from a substance which itself contains carbon more or less abundant and divided. This solution is obtained very varied, and in a number of chemical operations, from the simple exposure of charcoal, in a glass full of hydrogenous gas, to the rays of the sun—in which exposure the charcoal is seen to dissipate, and the hydrogenous gas to diminish in volume in proportion as it is dissolved.

It is also produced by the rapid decomposition of vegetables by heat, as well as by the spontaneous change which vegetable and animal substances undergo at the bottom of stagnant waters. In all these circumstances, carbonated hydrogen gas is obtained. Charcoal itself, when humid, or when it has been for some time immersed in hydrogen gas, begins, when lighted, to exhale through the atmosphere this deleterious gas, which also augments the danger of its combustion in close places.

Carburetted hydrogen gas, formed so easily in all the conditions here explained, varies according to the proportions of carbon which it contains, and assumes properties varied, also according to these proportions, in such a manner, that it has been regarded and described as if it formed so many different inflammable gases. That which is disengaged from stagnant waters or bogs, from peat, privies, and sinks; that which is obtained from the solution of some carbonated metals during their oxydation in the weak acids;

* When the simple combustibles, carbon, sulphur, or phosphorus, combine with any substance, the compound is called a carburet, sulphuret, or phosphuret, according as one or other of these bodies enters into combination with the substance. If any of these bodies combine with each other, the compound is denoted by placing the name of that substance first which predominates in the compound. Thus, if phosphorus and sulphur are combined in such a proportion that the phosphorus predominates, it would be called phosphuret of sulphur.

† This gas is called carburetted hydrogen by some chemists, and carbonated by others—we shall generally use the first of these terms.

that which frequently exhales from coal pits, from the mouths of volcanoes; those gases which are derived from vegetable and animal matters distilled at different temperatures, from alcohol, from ether, from oils, treated by different re-agents, particularly by the concentrated acids;—all these different inflammable gases are carburetted hydrogen gas, forming as many varieties as there are different proportions of their principles; and sometimes also other combustible matters are added to the carbon, dissolved in hydrogen gas, which always forms its base, or radical.

However numerous the varieties of carburetted hydrogen gas may thus appear, as well as the properties which it presents, there may, however, be discovered in the whole of these varieties, a series of characters which connect them, and which constitute them a distinct genus of compounds. It is very evident, that we must here attend only to the *generic*, or general characters. Carburetted hydrogen gas is heavier than pure hydrogen gas, and can but seldom be used for inflating aerostatic machines; it has a fetid odor, which is so much the stronger as it holds more of carbon in solution; it extinguishes inflamed combustible bodies, and more completely stupifies animals than pure hydrogen gas; it, in general, burns with less rapidity than this last; its flame is often blue and pale, sometimes it is red or white, very brilliant, and, as it were, oily. It frequently deposits carbon, distinguishable by its black color, when treated by different processes; it is, in general, more easily and more abundantly condensed, or absorbed, by charcoal. In some circumstances it forms oil, and it has then been particularly named olefant gas, which will be treated of in another part of this work.

The uses of carbon are very numerous in chemistry; its strong affinity for oxygen is employed with great success. After hydrogen, this substance attracts it more strongly than any other body; and, at high temperatures, it even attracts oxygen more strongly than hydrogen itself: it is, for this reason, that we have placed it immediately after hydrogen.

It will afterwards be shown, that carbon is particularly used to abstract oxygen from many burned bodies, to reduce them to their simple state of combustibility. It is no longer doubtful, that carbon is a principle employed by Nature, in forming the greatest number of her compounds: it will be shown

hereafter, that it constitutes the base of all vegetable substances, and that it performs a very important part in the great work of animal economy.

A singular and important property of charcoal is that of destroying the smell, color, and taste, of various substances: for the first accurate experiment on which we are chiefly indebted to Mr. Lowitz, of Petersburg, though it had been long before recommended to correct the fœtor of foul ulcers, and as an antiseptic. Water, that has become putrid by long keeping in wooden casks, is rendered sweet by filtering through charcoal powder, or by agitation with it, particularly if a few drops of sulphuric acid be added. Common vinegar boiled with charcoal powder becomes perfectly limpid. Saline solutions, that are tinged yellow or brown, are rendered colorless in the same way, so as to afford perfectly white crystals. Malt spirit is freed from its disagreeable flavor by distillation with charcoal; but if too much be used, part of the spirit is decomposed. Simple maceration, for eight or ten days, in the proportion of about 1-150th of the weight of the spirit, improves the flavor much. It is necessary that the charcoal be well burned, brought to a red heat before it is used, and used as soon as possible, or at least be carefully excluded from the air. The proper proportion too should be ascertained by experiment on a small scale. The charcoal may be used repeatedly, by exposing it for some time to a red heat before it is again employed.

Charcoal is used on particular occasions as *fuel*, on account of its giving a strong and steady heat, without smoke. It is employed to convert iron into *steel*, by cementation. It enters into the composition of gunpowder. In its finer states, as in ivory black, lamp black, &c. it forms the basis of black paints, Indian ink, and printers' ink.

It has already been remarked, that the *diamond* is carbon nearly *pure*. This was verified in 1694 by the Florentine academicians, in the presence of Cosmo III. Grand Duke of Tuscany. By means of a burning-glass they consumed several diamonds.* Francis I., Emperor of Germany, afterwards witnessed the destruction of several more in the heat of a furnace. These experiments were repeated by Darcet, Rouelle, Macquer,

* Though the diamond was, till this period, considered to be incombustible, yet Sir I. Newton suspected that it was combustible, from the great power it has of refracting the rays of light.

Cadet, and Lavoisier; who proved that the diamond was not merely evaporated, but actually burnt, and that, if air was excluded, it underwent no change.

Mr. Lavoisier prosecuted these experiments with his usual precision; burnt diamonds in close vessels, by means of powerful burning-glasses; ascertained that during their combustion carbonic acid gas was formed; and that in this respect there was a striking analogy between them and charcoal, as well as in the affinity of both when heated in close vessels. A very high temperature is not necessary for the combustion of the diamond. Sir George Mackenzie ascertained that they burn in a muffle* when heated to the temperature of 14° of Wedgewood's pyrometer: a heat considerably less than is necessary to melt silver. When raised to this temperature they waste pretty fast, burning with a low flame, and increasing somewhat in bulk; their surface too is often covered with a crust of charcoal, especially when they are consumed in close vessels, by means of burning-glasses.

The experiments of Lavoisier have often been repeated by several chemists, particularly by Morveau and Tennant; and from the result of their experiments it is demonstrated, that the diamond affords no other substance by its combustion than pure carbonic acid gas; and that the process is merely a solution of diamond in oxygen gas, without much change in the volume of the gas.

The only chemical difference perceptible between diamond and the purest charcoal is that the charcoal contains a minute portion of hydrogen; it, therefore, becomes an important question to determine if this very minute portion of hydrogen can occasion so great a physical difference as exists between these substances. This is a question, however, that remains to be determined.

OF PHOSPHORUS.—Phosphorus, the third of the simple combustibles, when placed in the order of its affinity for oxygen, may be procured by the following process: put a quantity of bones into a crucible, and burn or calcine them, till they cease to smoke, or to give out any odor, and afterwards reduce them to a fine powder. Put 100 parts of this powder into a basin of porcelain or stone ware, dilute it with four times its weight of water, and then add gradually (stirring the mixture after every addition) 40 parts of sulphuric acid. The mixture will become hot,

* A muffle is a kind of small earthen-ware oven, open at one end, and fitted into a furnace.

and a vast number of air-bubbles will then be extricated. Leave the mixture in this state for 24 hours, taking care to stir it well every now and then with a glass or porcelain rod, to enable the acid to act upon the powder.

The whole is now to be poured on a filter of cloth; the liquid which runs through the filter is to be received in a porcelain basin; and the white powder which remains on the filter, after pure water has been poured on it repeatedly, and allowed to strain into the porcelain basin below, being of no use, may be thrown away.

Into the liquid contained in the porcelain basin, which has a very acid taste, pour nitrate of lead,* dissolved in water very slowly; a white powder will immediately fall to the bottom: the nitrate of lead must, however, be added as long as any of this powder continues to be formed, and when this ceases to be the case, throw the whole upon a filter. The white powder which remains upon the filter is then to be well washed, allowed to dry, and afterward mixed with about one-sixth of its weight of charcoal powder. This mixture is to be put into an earthen ware retort, and then put into a furnace, and the beak of it plunged into a vessel of water, so as to be just under the surface. Heat is now to be applied gradually till the retort be heated to whiteness. A vast number of air bubbles issue from the beak of the retort, some of which take fire when they come to the surface of the water. At last there drops out a substance which has the appearance of melted wax, and which congeals under the water. This substance is *phosphorus*.

An alchemist of Hamburg, named Brandt, who, in searching for the philosopher's stone, which he did not find, was the first who, by chance, in 1677, discovered this phosphorus, for which he did not seek. The singularity of this new product induced Kunckel to associate with one of his friends, named Kraft, to purchase the secret of its preparation: but Kraft having deceived his friend, by procuring the secret for himself, of which Kunckel knew nothing more than that the phosphorus was prepared from urine, this philosopher had the courage to undertake the work of discovery. He, at last, succeeded in obtaining phosphorus, which was

* This substance is procured by dissolving lead in nitric acid, or *aqua fortis*; but it, as well as the other substances which may be mentioned in the course of this part of our work, will be fully described under their proper head, or class to which they belong.

long called the phosphorus of Kunckel, on account of the success of his enlightened researches. Boyle passes also for having discovered phosphorus, and having deposited the process with the secretary of the Royal Society of London, in 1680. In 1679, Kraft brought a small piece of it to London, to show it to the king and queen of England. Boyle gave his process to Godfrey Hankwitz, a practical chemist of London, who, for many years, sold the product to all the philosophers of Europe. This last operator, and Kunckel, were, for some time, the only chemists who knew how to prepare it. Boyle, however, described his process in the *Philosophical Transactions* for 1680; and Kraft inserted his method in a treatise on phosphorus by the Abbe de Communes, published in June, 1683, though he had several times sold it before.

That of Brandt was communicated in Hooke's *Philosophical Collections*, published in English, in 1726, by Derham. Homberg published a process, which he said he had seen practised by Kunckel, in the *Memoirs of the Academy of Sciences* for 1692.

Phosphorus was, however, made but seldom, with difficulty, and in small quantities, in the laboratories, and it was a mere object of curiosity, and the subject of a few philosophical experiments. A small stick or two of phosphorus usually composed the whole portion in cabinets, when, in 1774, Gahn and Scheele, in Sweden, made a capital discovery, which greatly augmented the quantity of phosphorus produced in the laboratories, by showing that the acid from which it was extracted is abundantly contained in the bones of animals; but, notwithstanding all these researches, it is still the scarcest, the most expensive, and consequently the least employed, of simple combustible bodies.

Locomotive Steam Engine. By J. B. JERVIS.

To the Editor of the *American Railroad Journal*.

DEAR SIR,—The Locomotive Steam Engine for the Saratoga and Schenectady Railroad, of which I promised to give you some account, was put on the road the 2d inst. and has been in regular operation since, making usually two trips (equal 84 miles) per day, and carrying daily over the road about 300 passengers.

The Engine was made by George Stephenson & Co., at Newcastle, England. The boiler has tubular flues, on the same plan as all of recent construction at that

establishment. The leading objects I had in view in the general arrangement of the plan of the engine, did not contemplate any improvement in the power over those heretofore constructed by Stephenson & Co., but, to make an engine that would be better adapted to Railroads, of less strength than are common in England, that would travel with more ease to itself, and to the rail on curve roads—and would be less affected by inequalities in the rail,—than is attained by the arrangement in the most approved engines.

You are aware of the fact, that the Saratoga and Schenectady rail is constructed of timber, capped with an iron plate. This kind of road cannot be expected to bear as heavy weight on the wheels of its carriages as those that have an entire iron rail; and, in order to obtain that degree of power which is desirable for an engine intended for high speed, it became an object to put the weight on six wheels, instead of four. Engines mounted on six wheels were constructed several years ago in England. The object was to distribute the weight on more points, to make them easier for the road than the four wheeled engines; for even with the iron rail, the heavier carriage is injurious to the road. There was a difficulty, however, in the practical operation on the plan adopted. The load was forced to bear at times very unequally on different wheels, owing to inequalities in the road; and having all their wheels under one frame, they did not work as well on curved roads as the four wheeled engines, which could be geared much shorter. In consequence mainly of these difficulties, the six wheeled engines were abandoned, and I believe no attempt has since been made in England to use more than four wheels.

In the Saratoga engine, I have adopted two distinct frames. One frame embraces four wheels in the same manner as a common waggon: these wheels are all small (32 inches) in diameter, and of uniform size: one end of the second frame is mounted on the third pair of wheels, which are the working wheels, and the other end is rested on friction rollers in the centre of the first frame, to which it is secured by a strong centre pin. The small wheels, with their frame, work on the road the same as an independent waggon; and being geared short, they go round a curve with as much ease as a common waggon, and being the leaders, they bring round the working wheels, and the large frame on which the whole machinery of the engine rests, with as much ease as practicable. By

this method it will be seen the engine may pass a curve with the same ease as a common railroad carriage, having the same weight on the wheels. The machinery of the engine is not affected by the curve motion of the carriage. In order to give the four wheeled engine carriage as much facility as practicable in turning curves, the wheels have generally been placed near together, bringing the bracing points of the frame so near the centre, in a longitudinal direction, as to cause the inequalities of the rail to produce increased motion to the ends of the frame, and consequently to the engine and boiler which is connected with it. This, in the English engine belonging to the Mohawk and Hudson Company, was such as to render the motion very unfavorable to the engine, and severe on the road. By allowing the bearing points to be near the ends of the large frame, and resting one of these points on the centre of the small frame, as is done in the Saratoga engine, this difficulty is almost entirely remedied.

The engine was set up at the shop of the Mohawk and Hudson Railroad Company, under the direction of Mr. Asa Whitney, the present superintendant of that road, and who has from its commencement had charge of the machine shop connected with it.

Thus far the engine appears to do all that was anticipated from it. No test has yet been made of its power; but, from the rapidity with which it generates steam, there appears no doubt of its performing all that it was calculated to do. It passes a curve without any more appearance of labor than a well geared common carriage. The principle of its arrangement does not admit of more strain coming on any one wheel than is assigned for its regular labor. The motion of the engine is highly satisfactory; it moves with almost as smooth and steady a motion as a stationary engine; it travels over the road in an elegant and graceful style.

I made a plan for a six wheeled engine for the Mohawk and Hudson road, which was completed and put in operation before I made the plan for the Saratoga engine. This engine proved satisfactory so far as regarded the principle of a six wheeled carriage, and was an important pioneer for the second plan. The superior ease with which this engine moved, both for its own machinery and the road, led to the determination to alter the English engine on the Mohawk road, so that it could be placed on a six wheeled carriage.

As the engine was particularly arranged for four wheels, this could not conveniently be done in any other way than by communicating the power through the intervention of a bell-crank, which was very successfully done by Mr. Whitney. This engine is now working on six wheels, and the ease and smoothness of her motion, over that she had when on four wheels, is very striking.

The arrangement on six wheels does not admit of the wheels under the main frame being connected with those under the small frame; consequently, we can only obtain the adhesion of one pair of wheels. This, however, is hardly of any importance when high speed is wanted.

Should further experience confirm what the operations thus far appear to warrant, the plan of the Saratoga engine may be viewed as a valuable improvement. She has used for fuel a coke of inferior quality, made in New-York, with which she has worked very well.

Yours, &c. J. B. JERVIS.

Albany, 18th July, 1833.

History of Astronomy. [Continued from page 34.]

Meton and Euctemon, two Greek astronomers, accordingly applied themselves to the study of this subject with great industry; and by sagaciously combining all the observations then known, formed a luni-solar period, or cycle of 19 years. This cycle was adopted on the 16th of July, in the year 433 B. C. and is still in use. It is called the Metonic cycle, after the inventor of it. In this discovery is visible very extensive astronomical knowledge, and every appearance of great accuracy. Such was its success in Greece, that the order of the period was engraved in letters of gold, and at this period goes by the name of the Golden Number.

Among the ancients Eudoxus is particularly distinguished for his knowledge, and also for his attention to astronomy. He built an observatory at Cnidus, his birth-place, which was shown long after his death. He invented a sphere, (which is called Eudoxus' sphere,) to show the rising and setting of the sun and moon, &c., for the climate of Greece.

He also composed two books on Astronomy: the one was a description of the constellations, the other treated on the times of their rising and setting. Aratus, by order of Antiochus, king of Macedon, reduced all that was then known of astronomy into Greek verse, anno B. C. 276. This poem is divided

into two books, one of which describes the sphere of Eudoxus; the other gives rules for predicting the weather. Both of these have reached us entire.

While astronomy made such great progress in Greece, it was cultivated also by some of the western nations of Europe. Pytheas, a celebrated astronomer at Marseilles, observed in that city the meridian altitude of the sun, at the time of the summer solstice, by a gnomon for the purpose of determining the latitude of that place. This man travelled to other parts of the globe, for the purpose of observing the phenomena of nature. He mentions having visited an island, which he calls Thule, where the sun rose presently after he had set. As this is the case in Norway and Iceland, it is inferred that he had reached these countries.

The same philosopher discovered that the polar star is not precisely at the pole itself. He likewise pointed out the connection of the tides with the motion of the moon.

Alexander the Great, by his conquests, rendered great service, both to Astronomy and Natural Philosophy. On these subjects, Aristotle wrote, by his order, a great number of books. In one of these, entitled *De Calo*, he proves the spherical shape of the earth, from the circular shadow it casts on the moon in eclipses, and also from the difference of altitude observable on any of the fixed stars, in travelling north or south. He wrote one called *De Mundo*, which gives an account of the three quarters of the globe then known, viz.: Asia, Africa, and Europe.

From this time geography gradually became (through its alliance with astronomy) a real science.

Horace mentions that the earth had been measured before his time: for he calls Archytas, who had been Plato's master, the measurer of the earth.

But the first person who measured the earth by a method consistent with the principles of Geometry and Astronomy, was Eratosthenes, librarian of the Alexandrian Museum. As this measurement was performed in a somewhat curious manner, it may be gratifying to the reader here to mention it, as it will serve to give some idea how that has lately been performed in Europe.

Eratosthenes was informed, that, on the day of the summer solstice, the sun was vertical at noon to the city of Syene, on the borders of Ethiopia, under the tropic of Cancer. A well is particularly mentioned to have been illuminated to the bottom by the

sun at noon, on the solstitial day. He knew likewise that Alexandria and Syene were both under the same meridian.

From these data, by means of a concave hemisphere, with a stile fixed in its centre, he found that the shadow of the meridian sun, caused by the stile at Alexandria, was one-fiftieth part of the whole circumference. Hence he inferred, that the arc of the heavens comprised between Alexandria and Syene must be the same; and that the distance between the two cities must likewise be a similar arc, or 1-50th part of the circumference of the earth. On measuring this distance, he found it to be 5000 stadia, which gave 250,000 stadia for the circumference of the earth. As there were different stadia then in use, it is not well ascertained how many feet a stadium contained. If it was the Egyptian stadium that was used, this measurement exceeds the modern measures about a sixth part.

About the same time with Eratosthenes, flourished Aristarchus of Samos, who has given a very simple method of determining the ratio of the distance of the sun and moon from the earth, which, though not very accurate, is yet ingenious.

Of all the ancient astronomers, no one has so much enriched the science, or acquired so great a name, as Hipparchus, a native of Nice, in Bithynia, 142 B. C.

One of his first cares was to rectify the year, which before his time was made to consist of 365 days 6 hours, which he found to be a little too much. He also found that the sun was longer in traversing the six northern signs of the ecliptic than the other half of it; and deduced from this the eccentricity of the solar orbit.

He likewise made similar remarks and calculations for the lunar orbit.

From these data, he constructed tables of the motions of the sun and moon, which are the first of the kind that are mentioned.

Hipparchus made another important discovery. He found that the stars always preserved the same relative positions with respect to each other; but that they had all a trifling motion in the order of the signs of the zodiac, which was about 48" in a year. He also substituted a more complete mode of measuring the ratio of the distance of the sun and moon from the earth, than the one given by Aristarchus. He made use chiefly of parallaxes, which is the method now in use. On the disappearance of a very large star, he set about numbering the stars, and to note

down their configurations, respective distances, &c., and gave a very good catalogue of them. This immense labor laid the foundation on which the whole superstructure of astronomy was to be raised. He was admired and celebrated in all nations where learning was pursued. Hipparchus was the first who applied this science to familiar purposes of the greatest utility in geography, by determining the situation of places by their latitudes and longitudes.

Cleomedes, who lived a little later than Hipparchus, has left a work on the sphere, the periods of the planets, their distances and magnitudes, with an account of ancient eclipses, which he says he derived the knowledge of from Pythagoras, Eratosthenes, and Hipparchus. This work is valuable, as it is the most ancient that has reached us on these subjects.

The next person that claims particular notice was Julius Cæsar, who rendered an important service to the science of astronomy, by new-modelling the Roman calendar, B. C. 46 years.

Cæsar appears to have been well versed in astronomy. He discovered that autumn occupied the place of the winter months of the calendar, and that winter occurred in the months of spring. He invited the astronomer Sosigenes from Athens to Rome, to assist him in correcting this disorder. They began by giving fourteen months to the year of Rome, to re-establish the order of the seasons. They likewise determined that the year should consist of 365 days 6 hours in future; but, as we shall afterwards see, this was making the year too long by 11' 11"; yet this was coming wonderfully near the real length of the tropical year, considering the state of science at that time. This is still called the Julian year, out of compliment to Julius Cæsar.

Menelaus, a learned geometrician, A. D. 55, also distinguished himself in astronomy, by the discovery of the principal theorems of spherical trigonometry, which are applicable to the purposes of astronomy.

Astronomy had begun to languish in the school of Alexandria, when the celebrated Ptolemy made his appearance, in A. D. 140.

He was a native of Pelusium in Egypt, and, when very young, came to Alexandria to study in that school. His principal work is entitled the *Almagest*, an Arabic word, which signifies the *great collection*. It contains all the ancient observations and theories, to which his *own* researches are added,

and is considered as the most complete collection of ancient astronomy that ever appeared.

Ptolemy embraced the common opinion, that the sun, moon and planets moved round the earth as their common centre. This system continued to maintain its ground till the time of Copernicus, and has descended from Ptolemy to the present day, under the name of the Ptolemaic System.

Besides the *Almagest*, there exists another great work of Ptolemy's, his *Geography*, in which he determines the situation of places by their latitude and longitude, according to the method of Hipparchus. Ptolemy had the ambition, like Archimedes, to transmit the remembrance of his labors to posterity, by a public monument. In the temple of Serapis, at Canopus, there is an inscription on marble, in which are explained the hypothesis of his astronomical system, such as the length of the year, the motions of the planets, &c. If there have been men of greater genius than Ptolemy, there is no man that ever collected a greater body of profound knowledge, or more truly conducted to the progress of astronomy, considering the age he lived in, and the time he wrote.

From Ptolemy to the time of the Arabs, no astronomer of the first order is to be found among the Greeks, except, perhaps, Theon of Alexandria, who wrote a learned commentary on the *Almagest*, about the year 395.

Among the Arabs there have been many excellent astronomers. As there was no science to which they devoted so much attention, there were none in which they made so many discoveries. Their Caliphs were particularly distinguished for their knowledge and patronage of this science. They soon found that Ptolemy had stated the obliquity of the ecliptic a little too great; and, after many observations, found it to be nearly what it is at present.

The Caliph Almansor the Victorious, who ascended the throne in 754, ranks among the first of their astronomers. Haroun, his grandson, who reigned from 786 to 809, sent a present to Charlemagne of a water clock, in the dial of which were twelve small doors, forming the division of the hours. Each of these doors opened at the hour it marked, and let out little balls, which, falling on a bell of brass, struck the hours. The doors continued open till 12 o'clock, when 12 little knights, mounted on horseback, came out together, paraded round the dial, and shut all

the doors. This clock at that time astonished all Europe.

After Haroun, his son Al Maimon succeeded to the throne. He also cultivated the study of astronomy. In his time there lived several celebrated astronomers: among whom was Alfragan, who composed several books on astronomy; and from his facility in calculation, he was surnamed the Calculator.

Albategni was also among the greatest of the Arabian astronomers. He found the year to contain only two minutes less than what it was found to be by Dr. Halley, 600 years after.

After the Arabs had conquered the greater part of Spain, in the year 1020, they built there many observatories to conduct their observations. Alhazen, one of their astronomers, has left a treatise on optics, which contains the first established theory of refraction and twilight which we have.

Among the Persians, also, there have been many eminent astronomers. They made many observations to discover the real length of the solar year, which they fixed at 365 days, 6 hours. One of their chief astronomers was the famous Ulugh Beg, grandson of Tamerlane; he not only encouraged the sciences as a sovereign, but was himself reckoned one of the most learned men of his age. To determine the latitude of Samarcand, it is said he employed a quadrant, the radius of which was 180 feet!*. He composed a catalogue of the stars, and several astronomical tables, the most perfect then known in the east. He was assassinated by his own son.

From the year 800 till the beginning of the fourteenth century, almost all Europe was immersed in gross ignorance. The only people who paid any regard to science was the Arabs that settled in Spain, some of whom have been mentioned above. Profiting by the books they had preserved from the wreck of the Alexandrian library, they cultivated and improved *all* the sciences, and particularly astronomy, in which they had many able professors.

From the beginning of the ninth century to the year 1423, when Purbachius appeared, there is no name that deserves to be mentioned as contributing to the improvement of astronomy. Purbachius was a man of great talents; he began an *Epitome of Ptolemy's Almagest*, but died before it was completed.

* It is thought by many astronomers, that this must have been a gnomon instead of a quadrant.

This was executed by his friend and pupil, John Muller, commonly called Regiomontanus. This man made many observations, and collected the writings of many of the ancient astronomers. He published ephemerides for thirty years to come, wrote a theory of the planets and comets, and calculated a table of sines and tangents for every degree and minute of the quadrant. He died in the year 1476.

Nicolas Copernicus, born 1473, rose next, and made so great a figure in astronomy, that the true system, discovered, or rather renewed by him, has been ever since called the Copernican System. He restored the old system of astronomy taught by Pythagoras, which had been set aside from the time of Ptolemy. His understanding at once revolted against the explanations which that philosopher had given of the motions of our planetary system; and set about correcting his mistakes, by laying the foundation of what is at this day held to be the true system of the world. This system he gradually improved by a long series of observations, and a close attention to the writings of ancient authors. His first grand work was printed in 1543, under the care of Schoner and Osiander; and he received a copy of it only a few hours before his death, on the 23d May, 1543, at the age of seventy years.

After the death of this great man, there were several astronomers of considerable note, that greatly improved the science; but the only one that claims particular notice was Tycho Brahe, a Danish nobleman, who was the inventor of a new system, a kind of semi-Ptolemaic, which he vainly endeavored to establish instead of the Copernican. His numerous works show that he was a man of great abilities; and it is to be regretted that he sacrificed his talents, and perhaps his inward conviction, to superstitious considerations. He restored the earth to its fancied immobility, and made the sun and moon revolve round it; but the planets he made to revolve round the sun, which was a still more absurd hypothesis than that of Ptolemy. But we ought to forgive this error, or rather weakness, in return for the many observations and discoveries with which he enriched astronomy. No man ever made more observations than Tycho Brahe.

Contemporary with Tycho flourished several eminent astronomers, among whom was the famous Kepler. To him we owe the true figure of the orbits of the planets, and the proportions of the motions and dis-

tances of the various bodies which compose the solar system. The three great laws of Kepler may be said to be the foundation of all astronomy. Kepler was born in 1571, and died in 1631.

Galileo was the next person who rendered any very important services to astronomy. He was the first who applied the telescope to astronomical observations, and with it made many useful and valuable discoveries. By the observations and reasoning of Galileo, the system of Copernicus acquired a probability almost equivalent to demonstration. By espousing the opinions of Copernicus, he drew on him the vengeance of the Inquisition, who decreed that he should pass his days in a dungeon; but he was liberated after the expiration of a year, on condition that he should never more teach or hold up the Copernican as the true system of astronomy. He was born in the year 1564, and died in 1642.

In spite of the Inquisition, or the passages in Scripture which were always brought forward as objections to the motion of the earth, the system of Copernicus gained ground every day.

Contemporary with Galileo were a number of astronomers, who contributed to the progress of the science. Baron Napier published his tables of logarithms in 1614. Bayer, also, obtaining great celebrity, by the publication of his *Uranometria*, in which the stars were designated by the letters of the Greek alphabet, which is still the case on our celestial globes and planispheres.

Gassendi, a French philosopher, saw the planet Mercury on the sun's disc, which was the first observation of the kind. A little after this, in the year 1633, Mr. Horrox, an Englishman of very extraordinary talents, discovered that Venus would pass over the disc of the sun on the 24th November, 1639. This event he only mentioned to one friend, a Mr. Crabtree; and these two men were the only persons in the world who observed this transit, which was the first transit of Venus that had ever been viewed by human eyes. Mr. Horrox made many useful observations about this time, and had even formed a new theory of the moon, so ingenious as to attract the attention of Sir Isaac Newton. But the hopes of astronomers, from the abilities of this extraordinary young man, were soon blasted, for he died in the beginning of the year 1640, aged twenty-four years.

Helvelius, burgomaster of Dantzic, also

rendered himself eminent by his numerous and delicate observations. He founded an observatory at Dantzic, and furnished it with a great many excellent instruments, some of which were divided into so small divisions as 5". His observations on the spots of the sun, and on the nature of comets, were very numerous; and his catalogue of fixed stars, containing the longitude of above 1888, was remarkable for its accuracy. It is to him also we are indebted for the first accurate description of the spots on the moon.

The improvement of the telescope continued to lay open new sources of discovery. The celebrated Huygens constructed two excellent telescopes, one of twelve feet in length, and the other twenty-four, with which he discovered the fourth satellite of Saturn; which he said afterwards led him to discover the *ring* that surrounds that planet. Huygens was likewise the first person who applied pendulums to clocks. He died in 1695, aged 66 years.

About this time, the Royal Society of London and the Royal Academy of Paris were established, each of which has produced astronomers of the first order. The first person appointed to conduct the observations at the royal observatory at Paris was Dominic Cassini, who soon after discovered the first, second, third, and fifth satellites of Saturn. He also discovered that the planets Jupiter, Mars, and Venus, turned round their axes in a manner similar to the earth. He died in the year 1712.

The successive propagation of light, one of the most curious discoveries in astronomy, was about this time made by Roemer, a Danish astronomer. This has ever since been accounted a most essential element in astronomy, and must secure immortality to the name of Roemer.

England, at all times, produced astronomers of the first order; and at this period it had to boast of Hook, Flamstead, and Halley.

Hook was born in 1635, and died in 1702. He was not only a great observer in every branch of astronomy, but his inventive powers have been exhibited in almost every branch of science. He was the inventor of the Zenith Sector, an instrument which was used to determine whether or not the earth's orbit had any sensible parallax. He gave the first hint of making a quadrant for measuring angles by reflexion; and he, in some measure, anticipated the discoveries of Newton, by showing that the motion of the pla-

nets resulted from a projectile force combined with the attractive power of the sun.

Flamsteed was born 1646, and died in 1720. After the royal observatory at Greenwich was finished, he was appointed by King Charles II. to the management of it, with the title of Astronomer Royal. He made a very great number of observations, which he has recorded in his *Historia Cælestis*, and in the Philosophical Transactions. But the principal service he rendered astronomy was by forming a catalogue of 3000 fixed stars, visible in our climate.

Flamsteed was succeeded, in 1719, by Dr. Halley, the greatest astronomer, says M. de la Lande, in England; and Dr. Long adds, "I believe he might have said the whole world." He was sent by King Charles II. to St. Helena, in order to form a catalogue of the stars in the southern hemisphere, which was published in 1679. While he was in the island of St. Helena, making this catalogue, he had an opportunity of observing a transit of Mercury across the sun's disc, by which he was enabled to point out the method of determining the parallax of the sun.

On his way between Calais and Paris, he obtained a sight of the famous comet that appeared in 1680, which suggested to him the idea of writing a treatise on the subject of comets, in which he investigates the orbits of these wandering bodies, and predicted the return of the one that appeared in 1759, which is the only prediction of the kind that ever was verified. It is said that during the nine years he was at Greenwich, he made 1500 observations. Halley was acquainted, either personally or by letter, with every astronomer of note in Europe then living. He died in 1742, aged eighty-six years; and was succeeded by Dr. Bradley, to whom we are indebted for two of the most beautiful discoveries of which the science can boast: the aberration of light, and the mutation of the earth's axis. He also made a great many observations, in order to discover if the fixed stars had any sensible parallax. These observations are partly published, and the remainder of them are in the hands of a Mr. Abraham Robertson, to whom their publication was entrusted. Bradley died in the year 1762.

But to no individual is the science of astronomy more indebted, than to the celebrated Sir Isaac Newton. This great man was born on the 25th December, 1642, at Woolstrop, in Lincolnshire. His discoveries were not confined to astronomy alone; for in ma-

thematics and natural philosophy he was equally great. His chief discovery in astronomy was the law of gravitation, by which he was enabled to account for some of the greatest phenomena in nature. His great work, the *Principia*, appeared in 1686. This work is one of the most valuable books on physical astronomy that ever was published. His discoveries are so numerous and important in this science, that the solar system, or that restored by Copernicus, has received the appellation of the Newtonian system.

In this country there have been several distinguished astronomers since the time of Newton, among whom may be mentioned Dr. Long, Dr. Keil, Dr. Bliss, Mr. Ferguson, Mr. Hadley, and Dr. Herschel; the latter of whom, for his many accurate observations, deserves to be ranked among the first class of astronomers of any age or nation. In the year 1781, on the 13th of September, he discovered the planet Georgium Sidus. In the year 1787, he discovered two satellites revolving round that planet; and in 1790 and 1794, he discovered other two satellites. These discoveries of Herschel form a new era in astronomy.

Dr. Maskelyne, the late astronomer royal, has likewise rendered very important service to the science. He was the first who proposed to the Board of Longitude the publishing of an ephemeris or nautical almanac, which was begun in the year 1767. This almanac is still continued annually, and has been of the utmost service to navigation.

Dr. Maskelyne died a few years ago, and was succeeded by the present astronomer royal, Mr. Pond, who is also a man of genius, and promises to be of great service to astronomy.

On the continent also there have been many astronomers of great talents since the time of Newton, particularly in France. Among these, La Caille deserves to be mentioned with credit. He was born in 1713, and in the year 1751 he undertook a voyage to the Cape of Good Hope, for the purpose of perfecting the catalogue of the stars in the southern hemisphere. After incredible labor and exertion, he returned to Europe with a catalogue of 9800 stars, which were comprehended between the south pole and the tropic of Capricorn. In addition to these labors, La Caille calculated new tables of the sun, made observations on the parallax of Mars and Venus, on atmospherical refraction, on the length of pendulums, and measured a degree of the meridian during his

stay at the Cape: he died in the year 1762. Contemporary with La Caille lived several very eminent astronomers, of whom may be mentioned Cassini, Bouguer, Condamine, Maupertuis, and Clairaut, who were all employed soon after this in measuring degrees of the meridian in different parts of the world. Professor Mayer, of Gottingen, deserves also to be mentioned, as contributing greatly to the improvement of this science, by the excellent set of tables which he calculated for finding the place of the moon, &c. These tables are now used in making the calculations of the nautical almanac. His widow received £3,000 for them from the British government, on account of their great accuracy. Mayer died in 1762, aged 41 years. D'Alembert also rendered great service to astronomy by his indefatigable labors, particularly in resolving the problem of the precession of the equinoxes. He died in 1783.

Euler, one of the greatest geniuses and calculators that any age or nation can boast of, ought to be associated with the history of astronomy, as one of its most distinguished votaries and improvers. By his many and accurate calculations, he has rendered the most essential service, not only to astronomy, but to all the physical sciences; but his labors are too numerous to be detailed here. The eighteenth century was distinguished by many other eminent astronomers, viz. Mac-laurin, Simpson, Bernoulli, Lambert, Mason, Boscovich, De Lisle, Bailly, La Lande, &c.

The celebrated La Grange, who outlived most of his contemporaries, was born at Turin, in 1736, and has enriched astronomy with some of the most splendid discoveries of which it can boast. The subjects of his researches in this science were, the theory of Jupiter's satellites, the motions of the planets, and their action on each other, which he determined with great accuracy.

As the labors of the most distinguished astronomers that have appeared in the world have now been briefly noticed, and of whom their labors are the only memorials that exist, all that remains to complete this short account of the improvements that have taken place in the science, down to the present day, is to mention the labors of a few individuals still alive.

La Place has also distinguished himself by his labors to improve astronomy, particularly in solving the problem of the tides,—in adding some new corrections to the lunar tables, and some discoveries respecting the precession of the equinoxes. He also as-

certained the mean depth of the sea to be four leagues.

The name of Troughton ought also to be mentioned; for to no other individual of the present age is *practical astronomy* more indebted than to this distinguished artist. The great improvements he has made upon astronomical instruments has rendered his name celebrated in every country in Europe. There is scarcely an observatory of note to be found that does not contain some of Mr. Troughton's instruments.

The labors of Dr. Olbers, Harding, and Piazzi, will be noticed in treating of the new planets.

On Wood Rails and Cast Iron Plates. By H. R. D. To the Editor of the American Railroad Journal.

SIR,—Having recently noticed in your valuable Journal a highly interesting discussion on the ultimate wear and strength of wrought and cast iron bars, when adapted to railroad purposes on wood as well as of stone, I now beg leave, through the medium of your journal, to offer a few remarks for the amusement of your readers, if not for their information, on the subject of wood rails and cast iron plates. In discussing the question in point, care should be taken to fix a data whereby the man of experience is enabled to direct just and conclusively. How it is that the wood rail lasts no longer than from five to six years, at present, I am unprepared to answer, unless from the inferiority of the same before laid down. One thing is well known, and that by many in this city, that pitch pine has been used for cisterns, which are alternately wet and dry, for the space of from twenty to thirty, and fifty years, when from various causes they have been taken up, and to the surprize of many were as sound as when put down. This was pitch pine, without any sap whatever, and this, too, what I would propose and prefer to stone in all cases where it could be obtained. Its cost is much less, more readily transported, less for labor on the same, and greatly facilitates the building of the road. In wet and spongy places it is highly preferable, as it would need regulating no oftener than half the expense to adjust it. This, covered with cast iron plates three inches wide and three-quarters thick, if practicable, in all cases to cast them in chills, say twelve feet long, so much the better, as the iron is so much stronger than when cast in an ordinary sand mould. I think, speaking from me-

mory, that iron cast in a chill is as twenty-seven to thirteen—nearly a half stronger. This was the case in a number of experiments made in this city, in the presence of several respectable practical men, myself being witness to the same. The experiment was tried with rollers cast in a chill, and those cast in the ordinary manner. The result was, to the best of my recollection, as is stated above. However, if it is of any consequence, I can state the exact comparative strength between the same, there shown: much might be said for the wood rail and cast plate. But the public in most cases have set their faces against it, and no man dare advocate the same unless at a risk of personal reputation. But the day is not far distant, in my opinion, at least, when wood rails and cast bars will be most generally used. Yours, most respectfully,

H. R. D.

ON SPECIFIC GRAVITIES.—The question is often asked, What is the meaning of specific gravity? Men of scientific turn, but without much system in regard to any science, find it difficult to comprehend the difference between *common weight* and specific weight.

The subject is an important one, and ought to be well understood by every mechanic as well as professional man. It will be my aim, in this essay, to give a concise view of this important subject, in a manner, I hope, intelligible to all readers.

Specific gravity is a term continually made use of in physical science. It is used to express the weight of any particular kind of matter, compared with the weight of the same bulk of some other matter, which is supposed to be well known and easily accessible. This latter is considered as unity, or 1, 100, or 1000, as may be found necessary. This is called the standard, or that to which the weight of all substances must be referred. The substance generally used for this standard is pure water.

The weights of bodies, in a philosophical sense, are considered as measures of the number of material atoms, or the quantity of matter which they contain. This is, on the supposition that every *atom* of matter is of the same weight, whatever may be its variable form. Reference is had to specific gravity for ascertaining the weight of an atom in various ways, which I shall hereafter illustrate.

Notwithstanding the changes which heat

and cold cause in the bulk of bodies, and the permanent varieties of the same kind of matter, caused by a variety of circumstances, of growth, texture, &c., most kinds of matter have a certain constancy in the density of their particles, and therefore in the weight of their bulk. Thus the purity of gold, and its degree of adulteration, may be inferred from its weight, it being purer in proportion as it is more dense. The density of different kinds of tangible matter becomes characteristic of the kind, and a test of its purity; it denotes a particular appearance in which matter exists, hence termed *specific*. But this density cannot be directly observed. It is not by comparing the distance between the atoms of matter in gold and in water, that we say the former is nineteen times denser than the latter, and an inch of gold contains nineteen times as many atoms as an inch of water; we calculate on the equal gravitation of every particle of matter, whether of gold or water; therefore the weight of any body becomes the indication of its material density, and the weight of a given bulk becomes *specific* of that kind of matter, ascertaining its kind and purity in their form.

In order to make this comparison of general use, it is evident that the standard must be familiarly known, must be uniform in its density, and the comparison of bulk and density must be easy and accurate. The most obvious method would be to form accurately a piece of the standard matter, of some convenient bulk, and to weigh it exactly, and rate its weight; then to make the comparison of any other substance, it must be made into a mass of the same precise bulk, and weighed with equal care. The most convenient way of expressing the specific gravity would be to consider the weight of the standard as unity, and then the number expressing the specific gravity is the number of times that the weight of the standard is contained in that of the other substances. This comparison is best made in fluids. We may make a vessel of known dimensions equal to that of the standard which we employ, weigh it when empty, and then when filled with the fluid. But a better way is, to use some fluid as a standard. Any vessel may then be substituted, and we may attain to very great accuracy, by using a vial with a slender neck, such as a small matrass; for when this is filled to a certain mark in the neck, any error in the estimation by the eye will bear a very small proportion to the whole. The weight of the standard fluid, which fills

it to this mark, being carefully ascertained, is noted. The specific gravity of any other fluid is obtained by weighing the contents of this vessel when filled with it, and dividing the weight by the weight of the standard; the quotient is the specific gravity of the fluid. But in all other cases, this is a very difficult problem. It requires very nice manipulations, and a very accurate eye, to make two bodies of the same bulk. It has been calculated that an error of 1-100 of an inch, in the linear dimensions of a solid body, makes an error of 1-30 in its bulk; and bodies of irregular shapes, and friable texture, cannot be brought into suitable dimensions for measurement.

These inconveniences and difficulties were relieved by Archimedes, who, from the principles of hydrostatics, deduced the accurate method which is now universally practised for discovering the specific gravity and density of bodies. Instead of measuring the bulk of the body by that of the displacing fluid, we have only to observe the loss of weight sustained by the solid. This can be done very accurately. Whatever may be the bulk of the body, this loss of weight is the weight of an equal bulk of the fluid, and we obtain the specific gravity of the body, by simply dividing its whole weight by the weight lost; the quotient is the specific gravity, when this fluid is taken for the standard, even though we should not know the absolute weight of any given bulk of this standard. We obtain, likewise, an easy and accurate method of ascertaining this fundamental point. We have only to form any solid body into an exact cube, sphere, or prism, of known dimensions, and observe what weight it loses when immersed in this standard fluid. This is the weight of the same bulk of the standard to be noted; and thus we obtain an accurate method for measuring the bulk or solid contents of any body, however irregular be its shape. We have only to determine how much weight it loses in the standard fluid; we can compute what quantity of the standard fluid will have this weight. Thus, if we should find that a quantity of sand loses two hundred and fifty ounces, when immersed in water, we learn from this that the solid measure of every grain of the sand, when added into one sum, is equal to the fourth part of a cubic foot, or to four hundred and thirty-two cubic inches.

The immediate standard, pure water, is, of all the substances with which we are acquainted, the best for an universal standard

of reference. In its ordinary natural state, (viz. rain water,) it is sufficiently constant and uniform in its weight for every examination, where the utmost mathematical accuracy is not wanted. All its variations arise from impurities, from which it may be separated by distillation. When pure, its density is invariably at the same temperature.

Water is therefore universally adopted for the unit of that scale on which we measure the specific gravity of bodies, and its weight is termed 1. The specific gravity of any other body is the real weight in pounds, or ounces, when of the bulk of one pound, or one ounce of water. It is, therefore, of the utmost importance, in all matters relating to the specific gravity of bodies, to have the precise weight of some known bulk of pure water.—[Young Mechanic.]

ON THE QUADRATURE OF THE CIRCLE.—

We have undertaken this article, because we have reason to know that there are still some persons, who, from ignorance of the real question, are turning their attention to this useless and exploded problem, and deceiving themselves and their neighbors into the belief that they have succeeded in doing that which has been repeatedly shown to be impossible. By the *rectification* of a circle is meant the finding of a straight line which shall be equal in length to the circumference of a given circle, or the two ends of which when bent around it should exactly meet; by the *quadrature* of a circle is meant the finding a square which shall be equal in surface to a given circle, that is, to the whole space contained inside its circumference. There is no difficulty in doing these problems in a manner more than sufficiently correct for all useful purposes. If, for example, we take a circle as large as the earth's orbit, and an atom as small as the smallest insect which a microscope ever showed in a drop of water, nothing would be more easy than to find the circumference of this circle so nearly that the error committed should be less than the length of that atom. The problem which has puzzled so many generations, is the finding what is called a *geometrical* quadrature of the circle. What this is we proceed to explain. It is the object of geometry to find out, by reasoning, all truths which relate to the various figures which a draughtsman can construct. Not that these figures are precisely the objects of geometrical reasoning, for a geometrical line has no breadth or thickness, but only

length, while the line we draw with a pencil has a small degree both of breadth and thickness. It is agreed by geometers to take as little for granted as possible, and to make all their propositions arise out of the smallest number of simple truths. It is also agreed to imagine the existence of as few figures as possible. It was therefore the practice of the ancient geometers to assume no problems except the following: 1. A straight line can be drawn from one point to another. 2. A straight line, when finished, can afterwards be made longer. 3. A circle can be drawn with any point as a centre, and any line as a radius. All lines, except the straight line and circle, and afterwards the conic sections, were called *mechanical*, as distinguished from geometrical lines; and if any problem arose, the first attempt was always to solve it geometrically, and only when that failed, were mechanical means resorted to, or were other curves constructed, the construction of which, *once granted*, solved the problem. The names geometrical and mechanical, as applied to distinguish one sort of solution from another, may be improper, but that is not the question. When a man asserts that he has found a *geometrical* quadrature of the circle, he either does or does not use the word in the sense of the ancient geometers. If he does, and his solution is correct, he has certainly solved the problem; but that no one has yet done this, is universally admitted. If he does *not* use the word geometrical in the ancient signification, his solution has nothing to do with the problem which has hitherto remained unsolved. Many ways have been discovered of finding the area of a circle, which take something more for granted than the use of the rule and compasses only, and any person, with a reasonable knowledge of mathematics, might add a dozen to the number in a couple of hours. So much for the geometrical solution of the problem.

It was proved long before the Christian era, that the circumferences of two different circles are to one another as the radii, that is, whatever number of times one circumference contains its radius, the other circumference contains its radius as many times, or whatever fraction one radius is of its circumference, the same fraction is the other radius of its circumference. From this it follows, that if any number of circles were taken, having for radii a foot, a yard, a mile, &c. whatever number of feet and parts of feet would go round the first,

the same number of miles and similar parts of miles would go round the third, and so on. Hence it became a question of importance to discover what was the number of units and parts of units contained in the circumference of a circle whose radius was the unit. Again, it was proved that the number of square feet and parts of square feet in a circle of one foot radius, was the same as the number of square miles and similar parts of square miles contained in the circle of one mile radius. Archimedes showed that a circle of one foot in radius contained nearly 3 square feet and $\frac{1}{4}$ of a square foot, which does not differ from the truth by so much as $\frac{1}{2}$ of a square inch, and gives the circle too great by about its three-thousandth part. An ancient measure of the Hindoos makes it 3 square feet and 177 parts out of 1250 of a square foot. This is much nearer to the truth, differing from it by about one-thousandth part of a square inch, but still a little too much. Metius, who flourished in the beginning of the seventeenth century, found that if a square foot be divided into 112 parts, the circle of one foot radius contains about 355 of these parts—a result of surprising accuracy when the simplicity of the numbers is considered; it is too great by about the fifty-thousandth part of a square inch. These numbers may be very easily recollected, since, when put together, they give the first three odd numbers, each repeated twice: thus, 113355.

The following simple rules will enable every one of our readers to find the circumference of a circle. If any one of them would go direct round the world, he would, by means of them, if the world were a perfect sphere, be able to tell the length of his journey within less than four yards. From them the word *inch* may be taken out and any other unit substituted.

To find the length of the circumference of a circle, multiply the number of *inches* in the diameter (or twice the radius) by 355, and divide the product by 113. The result is the number of *inches* in the circumference.

To find the area, or surface of a circle, multiply the number of *inches* in the radius by itself, and that product by 355; divide the result by 113, the quotient of which is the number of square *inches* in the area.

We might go on to describe still more accurate methods; it will be sufficient to say that the latest of them gives the area of a circle true to 127 decimal places, as it is

called; that is, if the radius be 1000, &c. feet, the ciphers being 127 in number, the area of the circle will be obtained without an error of a square foot.

Still, this is only an approximation, and however nearly the circumference of a circle has been obtained, it has never been obtained exactly. Numberless attempts have been made to find the exact ratio of the circumference to the diameter, but without success; the reason being, as was afterwards proved, that the thing is impossible. We can now demonstrate that the ratio of the circumference to the diameter cannot be *accurately* expressed in numbers; all we can do with numbers is to express it as nearly as we please. Thus, using decimals, we may say that the circumference of a circle whose diameter is 1 is greater than 3 and less than 4; greater than 3.1 and less than 3.2; greater than 3.14 and less than 3.15, and so on, assigning nearer and nearer fractions between which it must lie, but never coming to an exact result. Almost every projector who imagines he can solve this problem, is sure to produce some number or fraction as the *exact* ratio of the circumference to the diameter; and it is observable that, the less his knowledge of geometry, the more easily does he overcome the difficulty, and the more obstinately does he believe himself in the right. Some have been found hardy enough to deny the common propositions of geometry, in order to establish their own conclusion on this point. Others, totally ignorant of geometry, hearing that a circle could not be *exactly* measured, have imagined that the word *exact* was used in the sense in which a carpenter would take it, who, very properly for his purpose, considers two rods to be of exactly the same length, when they do not differ to the naked eye. These usually cut a circle out in wood, measure it with a bit of string, pronounce their result to be perfectly accurate, and are very much surprized that an ungrateful world does not perceive their claim to one of the first places in the ranks of science. We shall give some anecdotes connected with this subject, principally extracted from Montucla's History of the Mathematics.

In 1585, a Spanish friar published his quadrature of the circle. His preface is a dialogue between himself and the circle, who thanks him in most affectionate terms for having solved the problem. The circle, however, did not in this case attend to the maxim, "Know thyself," any more than some

of its squarers have since done, for the pretended quadrature was utterly wrong. The author of it was a modest man, and ascribed all the honor to the Virgin Mary. Another Knight of the Round Shield found out by his method that the first book of Euclid was all a mistake. About the same time a merchant of Rochelle discovered, not only the quadrature of the circle, but with it, and depending upon it, a method of converting Jews, Pagans, and Mahometans, to Christianity. In 1671 an anonymous writer published a treatise with the following title: "Demonstration of the Divine Theorem of the Quadrature of the Circle, of the Trisection of the Angle, and of the Perpetual Motion, and the connection of this theorem with the Vision of Ezekiel and the Revelation of St. John." A certain Cluver found out that this problem depended upon another, which he expressed thus: "Construere mundum divinæ menti analogum." The literal translation of this (the *sense* is unknown) is, "To build a world resembling the divine mind." But the most singular person was one Richard White, an English Jesuit, who having once undertaken to square the circle, was afterwards convinced by argument that he was in the wrong, which never happened to any other of this class of speculators, except perhaps to one Mathulon, a Frenchman of Lyons. This man offered to give a thousand crowns to any one who would detect an error in his solution. It was done to his satisfaction, but he refused to pay the money, and a court of justice decided that it should be given to the poor. So late as 1750, an Englishman, Henry Sullamar, found out the area of the circle by means of the number 666 mentioned in the Revelations. But in 1753 a Captain in the French Guards did more, for in squaring the circle, which he did with a piece of turf, he hit upon what he thought was a most obvious connection between this and the doctrines of original sin and the Trinity. He offered to bet three hundred thousand francs that he was right, and actually deposited ten thousand of them. A young lady and several other persons easily won the wager, and brought actions for the money; but the courts declared that the bet was void.

Such are a few of the most remarkable aberrations of the human mind on this problem. They show in the most convincing manner, that presumption is rarely confined to one subject in the same mind, and that a man, who, without studying a science, con-

ceives himself to be more knowing than those who have passed their lives in the pursuit of it, must previously have brought himself to believe that he is almost a God, and is but one step removed from taking the government of the universe out of the hands of its Creator, and arranging it according to his own improved notions.

With regard to a geometrical solution, and the possibility or impossibility of it, we shall now say a few words. We have already observed that an arithmetical solution is certainly impossible, that is, there is no number or fraction which *exactly* represents the circumference of the circle where the radius is a unit. In 1668, James Gregory, a well known name in geometry, asserted that a *geometrical* quadrature was impossible, that is, no use of the ruler and compasses could give a square of exactly the same dimensions as a given circle. Of this he published his demonstration, which was attacked by Huyghens, another geometer of the same time. The dispute has interested mathematicians so little for the last century and a half, that few of them seem to have cared which was right. The *historians* of mathematics have, of course, been obliged to give an opinion, and yet Montucla and Dr. Hutton both forbear to decide the question, each being apparently somewhat inclined to believe that J. Gregory was right. The demonstration of the latter appears to us to render it extremely probable that the geometrical quadrature is impossible; but we will not venture a positive opinion where such respectable authorities have declined to give one. But we would recommend any one who imagines he can give this solution, to learn geometry, to examine the demonstration of J. Gregory, which he will find in the library of the British Museum, and find out the error; and it deserves some attention, since neither Montucla nor Hutton, both very well informed mathematicians, would positively say it was false.

We would not have entered upon this subject at such length, if it were not that there appear, from time to time, pretended solutions of this problem. To any one who is ignorant of geometry, we would recommend to be sure of two things before he undertakes it: first, that he has an imagination which will set common sense at defiance, for without this he will never out-herod Herod so far as to produce any thing worthy of notice, after the instances which we have mentioned; secondly, that he has his own good opinion

to a very great degree, for, otherwise, his peace of mind will be disturbed, either by the neglect or ridicule which it will be his fate to meet with. To one who understands geometry, and who imagines himself to be the person destined by Providence to work this wonder, we have not a word to say: if the study of Euclid has not been sufficient to teach him more sense, or at least to induce him to wait until he knows more, we should almost rival him in absurdity if we thought him a proper subject for the language of common sense.

CLOTHING.—A very striking fact, exhibited by the bills of mortality, is the very large proportion of persons who die of consumption. It is not our intention to enter into any general remarks upon the nature of that fatal disease. In very many cases the origin of a consumption is an ordinary cold, and that cold is frequently taken through the want of a proper attention to clothing, particularly in females. We shall, therefore, offer a few general remarks upon this subject, so important to the health of all classes of persons. Nothing is more necessary to a comfortable state of existence, than that the body should be kept in nearly an uniform temperature. The Almighty Wisdom, which made the senses serve as instruments of pleasure for our gratification, and of pain for our protection, has rendered the feelings arising from excess or deficiency of heat so acute, that we instinctively seek shelter from the scorching heat and freezing cold. We bathe our limbs in the cool stream, or clothe our bodies with the warm fleece. We court the breeze, or carefully avoid it. But no efforts to mitigate the injurious effects of heat or cold would avail us, if nature had not furnished us, in common with other animals (in the peculiar functions of the skin and lungs), with a power of preserving the heat of the body uniform under almost every variety of temperature to which the atmosphere is liable. The skin, by increase of perspiration, carries off the excess of heat; the lungs, by decomposing the atmosphere, supply the loss, so that the internal parts of the body are preserved at a temperature of about 98 degrees, under all circumstances. In addition to the important share which the function of perspiration has in regulating the heat of the body, it serves the farther purpose of an outlet to the constitution, by which it gets rid of matters that are no longer useful in its economy. The excretory function of the skin is of such pa-

ramount importance to health that we ought at all times to direct our attention to the means of securing its being duly performed; for if the matters that ought to be thrown out of the body by the pores of the skin are retained, they invariably prove injurious. When speaking of the excrementitious matter of the skin, we do not mean the sensible moisture which is poured out in hot weather, or when the body is heated by exercise, but a matter which is too subtle for the senses to take cognizance of, which is continually passing off from every part of the body, and which has been called the *insensible perspiration*. This insensible perspiration is the true excretion of the skin. A suppression of the insensible perspiration is a prevailing symptom in almost all diseases. It is the sole cause of many fevers. Very many chronic diseases have no other cause. In warm weather, and particularly in hot climates, the functions of the skin being prodigiously increased, all the consequences of interrupting them are proportionably dangerous. Besides the function of perspiration, the skin has, in common with every other surface of the body, a process, by means of appropriate vessels, of absorbing, or taking up, and conveying into the blood-vessels, any thing that may be in contact with it. It is also the part on which the organ of feeling or touch is distributed. The skin is supplied with glands, which provide an oily matter, that renders it impervious to water, and thus secures the evaporation of the sensible perspiration. Were this oily matter deficient, the skin would become sodden, as is the case when it has been removed—a fact to be observed in the hands of washer-women, when it is destroyed by the solvent powers of the soap. The hair serves as so many capillary tubes to conduct the perspired fluid from the skin. The three powers of the skin, perspiration, absorption, and feeling, are so dependent on each other, that it is impossible for one to be deranged without the other two being also disordered. For if a man be exposed to a frosty atmosphere, in a state of inactivity, or without sufficient clothing, till his limbs become stiff, and his skin insensible, the vessels that excite the perspiration, and the absorbent vessels, partake of the torpor that has seized on the nerves of feeling; nor will they regain their lost activity till the sensibility be completely restored. The danger of suddenly attempting to restore sensibility to frozen parts is well known. If the addition of warmth be not very gradual, the

vitality of the part will be destroyed. This consideration of the functions of the skin will at once point out the necessity of an especial attention, in a fickle climate, to the subject of clothing. Every one's experience must have shown him how extremely capricious the weather is in this country. Our experience of this great inconstancy in the temperature of the air ought to have instructed us how to secure ourselves from its effects. The chief end proposed by clothing ought to be protection from the cold; and it never can be too deeply impressed on the mind (especially of those who have the care of children), that a degree of cold that amounts to shivering cannot be felt, under any circumstances, without injury to the health, and that the strongest constitution cannot resist the benumbing influence of a sensation of cold constantly present, even though it be so moderate as not to occasion immediate complaint, or to induce the sufferer to seek protection from it. This degree of cold often lays the foundation of the whole host of chronic diseases, foremost amongst which are found scrofula and consumption. Persons engaged in sedentary employments must be almost constantly under the influence of this degree of cold, unless the apartment in which they work is heated to a degree which subjects them, on leaving it, to all the dangers of a sudden transition, as it were, from summer to winter. The inactivity to which such persons are condemned, by weakening the body, renders it incapable of maintaining the degree of warmth necessary to comfort, without additional clothing or fire. Under such circumstances, a sufficient quantity of clothing, of a proper quality, with the apartment moderately warmed and well ventilated, ought to be preferred, for keeping up the requisite degree of warmth, to any means of heating the air of the room so much as to render any increase of clothing unnecessary. To heat the air of an apartment much above the ordinary temperature of the atmosphere, we must shut out the external air; the air also becomes extremely rarified and dry; which circumstances make it doubly dangerous to pass from it to the cold, raw, external air. But in leaving a moderately well-warmed room, if properly clothed, the change is not felt, and the full advantage of exercise is derived from any opportunity of taking it that may occur.

The only kind of dress that can afford the protection required by the changes of tem-

perature to which high northern climates are liable, is *woollen*. Nor will it be of much avail that woollen be worn, unless *so much* of it be worn, and it be *so worn*, as effectually to keep out the cold. Those who would receive the advantage which the wearing of woollen is capable of affording, must wear it next the skin; for it is in this situation only that its health-preserving power can be felt. The great advantages of woollen cloth are briefly these: the readiness with which it allows the escape of the matter of perspiration through its texture; its power of preserving the sensation of warmth to the skin under all circumstances; the difficulty there is in making it thoroughly wet, the slowness with which it conducts heat; the softness, lightness, and pliancy of its texture. *Cotton cloth*, though it differs but little from linen, approaches nearer to the nature of woollen, and, on that account, must be esteemed as the next best substance of which clothing may be made. *Silk* is the next in point of excellence, but it is inferior to cotton in every respect. *Linen* possesses the contrary of most of the properties enumerated as excellencies in woollen. It retains the matter of perspiration in its texture, and speedily becomes imbued with it; it gives an unpleasant sensation of cold to the skin; it is very readily saturated with moisture; and it conducts heat too rapidly. It is, indeed, the worst of all substances in use, being the least qualified to answer the purposes of clothing. There are several prevailing errors in the mode of adapting clothes to the figure of the body, particularly amongst females. Clothes should be so made as to allow the body the full exercise of all its motions. The neglect of this precaution is productive of more mischief than is generally believed. The misery and suffering arising from it begin while we are yet in the cradle. When they have escaped from the nurse's hands, boys are left to nature. Girls have, for a while, the same chance as boys, in a freedom from bandages of all kinds: but, as they approach to womanhood, they are again put into trammels in the form of stays. The bad consequences of the pressure of stays are not immediately obvious, but they are not the less certain on that account. The girl writhes and twists to avoid the pinching which must necessarily attend the commencement of wearing stays tightly laced. The posture in which she finds ease is the one in which she will constantly be, until at last she will not be comfortable in any other, even when she

is freed from the pressure that originally obliged her to adopt it. In this way most of the deformities to which young people are subject originate; and, unfortunately, it is not often that they are perceived until they have become considerable, and have existed too long to admit of remedy.—[Lardner's Cyclopædia.]

Machinery of Education. [From the *Annals of Education*.]

This is an age of labor-saving machines. By them, the power of man is increased several hundred fold. The surplus time, which in the rudest state of society is very great, after the ordinary and real wants of the body are supplied, is, by bringing the elements of nature and the principles of science to our aid, increased to nearly a thousand per cent. And how is this surplus time appropriated? This question is nearly answered in three words, viz. *idleness*, *extravagance*, and *vice*. How ought it to be appropriated? The answer is in two words: to *mind* and *heart*—intellectual and moral improvement.

But it may be said a part of this machinery is for moving mind and heart—for producing intellectual and moral improvement. That is true: and so is an improved plough designed to furnish a larger supply of bread, to feed the hungry, and an improved loom to supply more yards of cloth to clothe the naked; and yet, in the midst of improved ploughs and looms, we sometimes see more suffering with hunger and cold than before these improvements were made.

The machinery of education may also defeat the object which it is intended to promote. It may impair the efforts which it is intended to strengthen; weaken the intellect which it is designed to invigorate; and chill the heart which it was intended to warm. It may lead the mind and heart to wait to be acted upon, rather than to exert their own powers of action. By depending upon the machinery without, they will be liable to forget and neglect the machinery within.

These evils are felt to some extent already. The extent to which they are threatened is truly alarming. We have much reason to fear that they will give to the world a generation of weak minds, notwithstanding the boasted intelligence and the general diffusion of knowledge, which is certainly making rapid progress upon our globe.

What are the facilities of education which have already been so abused as to defeat the object which they are intended to pro-

mote, or which threaten still greater evils than they have already produced? To answer this question in detail, would require more time than we have at our command. The answer must therefore be brief, and embrace but a few particulars. The first facility in education which we shall mention, as productive of some evil with much good, is the *division of labor* in teaching. We are fully convinced that in some institutions, where the professors and teachers are numerous, they unconsciously take the work out of the pupils' hands—they perform the work which ought to be done by the pupils themselves. It is quite evident, that when a student spends most of his time in going from one lecture room or one teacher to another, and in sitting as a passive incipient of instruction, he can have but little time and less disposition to exert his own powers for accumulating knowledge and invigorating his mind. Who ever heard of a scholar made by lectures, or by teachers in any form? Has not every scholar who has yet appeared in the world become such by his own efforts,—by personal application—by the patient and persevering use of the machinery within him? Who ever heard of hereditary learning, or of ideas manufactured like cotton cloth—by steam or water power? The history of American colleges, for the last ten or twenty years, fully proves that students who perform the most mental labor for themselves, and not for those who hear the greatest number of professors, make the strongest and most valuable men. A *large library* is another facility in education, which, by abuse, is liable to do much injury: which *has* done much injury to students. A great reader, and especially a miscellaneous reader, is seldom a good scholar or a useful man. He may have a large mass of materials collected, but he has no power to use them, either for himself or his fellow men. His mind is a mere lumber-yard, and himself an intellectual miser—a blank in the beautiful and harmonious creation around him.

Apparatus for visible illustrations is liable to be so abused as to produce evil rather than good—to check, rather than elicit effort—to impair, rather than invigorate the mind. No one doubts the value of a globe or a map in teaching geography: but it is principally useful in animating the mind to greater efforts and further study of the surface of the earth, as represented in nature itself. Experiments in chemistry, when properly applied, may act both as a stimulus and an aid

in studying the great and wonderful laws in chemical science; but if witnessed as a dazzling sight, or a brilliant show, without recognizing the principles they are designed to illustrate, they may amuse, but they cannot instruct—they may elate, but they cannot dignify or strengthen the mind.

A cone cut into its several sections, viz. the circle, ellipse, triangle, parabola, and hyperbola, may render to the pupil the most important aid in getting clear and distinct impressions of the elementary and fundamental principles of conic sections: but if it leads him to conclude that the whole science on the subject consists in cutting a cone in five different ways, or otherwise prevents investigation and patient study, he is injured, and not benefitted.

A cube, and the various species of parallelepipeds, may be presented to a child, very much to his aid, in getting a clear and distinct idea of the elementary principles of solid measure; and may dispel darkness from every step of his future progress in the mensuration of solids, whether of wood, timber, bricks, walls, or of cisterns, casks, bins, or any other kinds of containing vessels. The light which they thus throw upon the subject at the outset of the pupil's progress, and the aid which they render him in his future investigations, may and ought to impart to him both courage and strength in grappling with the most abstruse and difficult principles of the science of geometry. But if by the abuse of them they lead the pupil to suppose that all geometrical science consists in measuring a few blocks, they check effort and weaken intellect.

The *Infant School System* has, by abuse, produced some evil with much good. It is the opposite extreme to our common school system, which produces some good and much evil. The common school, by withdrawing the child from every thing which has a tendency to excite and invigorate the mind, too often cramps its energies, and impairs its independence. The infant school, calculating principally upon excitement, surrounds the child with pictures, amuses it with stories, and soon brings the mind into such a state as not to be able to act at all, except when stimulated with external machinery. The one is hence calculated to benumb, the other to dissipate the mind. The proper course undoubtedly lies between them. A portion of the infant school machinery is needed to awaken interest and encourage effort. A portion of the common school system is

needed to cultivate patience, and to give the power of long continued effort.

The *picture system*, which is so much the order of the present day, undoubtedly produces some good, but it must unavoidably produce immense evil. Children, and adults too, are coming to feel that they cannot read a book or a paper which is not filled with "pretty pictures." But who ever heard of a person acquiring a strong or well disciplined mind by looking at pictures? Is it not evident that stimulants of this kind produce an effect upon the intellect and heart, resembling that of alcohol upon the body? When such excitements become necessary for intellectual effort, the mind does not move by its own inherent power, but by the influence of foreign or extraneous stimulants, and is consequently in a diseased state.

If then the faculties for acquiring knowledge are sometimes carried so far as to defeat the object they are intended to promote, it becomes a serious and most important question, how far they can be introduced for the advantage of the great cause of education. On that question it may perhaps be safe, in nearly every case, to be governed by one principle: which is to aim at encouraging and invigorating effort. All the facilities and all the aid a mind can receive to induce and enable it to increase its own efforts, will probably prove salutary: the moment a mind begins to depend upon the facilities afforded it, rather than upon itself, its efforts are impaired, and its growth checked. A distinguished teacher and president of a college defined genius to be "the power of making efforts." The most distinguished statesman of our republic once very modestly replied to some inquiries made by a friend respecting himself, that if he was superior to most others in any thing, it was in his power of fixing and confining his mind to a given subject for a long time. In other words, in his making vigorous and long continued efforts. The same remark was long since made by Sir Isaac Newton. This power is undoubtedly the essence of intellectual energy wherever it is found. Of course, whatever tends to give a mind that power over itself, is calculated to answer the legitimate and highest purposes of education. Whatever tends to draw away the mind from itself, and to lead it to depend upon foreign aid, whether it be in a multiplicity of teachers, voluminous libraries, scientific or illustrative apparatus, beautiful pictures, or fictitious or real stories, can hardly

fail to defeat the great purposes of education—to impair the intellects they are intended to strengthen, and dissipate the minds they are designed to sober and dignify.

A few cases will be sufficient to show the importance of some aid to the young mind, particularly in obtaining clear conceptions of the elementary principles of the subjects presented for its examination. A gentleman, not long since, took up an apple to show a niece, sixteen years of age, who had studied geography several years, something about the shape and motion of the earth. She looked at him for a few minutes, and said with much earnestness, "Why, uncle, you don't mean that the earth really turns round, do you?" He replied, "But did not you learn that several years ago?" "Yes, Sir," she replied, "I *learned* it, but I never *knew* it before." Now, it is obvious that this young lady had been laboring several years on the subject of geography, and groping in almost total darkness, because some kind friend did not show her at the outset, by a globe or an apple, that "the earth really turned round."

It is related by Miss Edgeworth, that a gentleman, while attending an examination of a school, where every question was answered with the greatest promptness, put some questions to the pupils which were not exactly the same as found in the book. After numerous ready answers to their teacher on the subject of geography, he asked one of the pupils where Turkey was. She answered rather unhesitatingly, "*In the yard, with the poultry.*"

Three or four years ago, a gentleman sold a right of some water for carrying a mill. The quantity first agreed upon was a stream which could be discharged through a two-inch tube. When asked what he should charge for the quantity which would pass through a four-inch tube, he answered, twice the price of the other. The purchaser, of course, obtained four times the water for twice the money, as a tax upon the seller's ignorance, which a glance at a diagram might have removed.

It was stated in one of the most respectable newspapers in Boston* a few days since, that London was seven miles long and five miles wide; and allowing for its irregular shape, was "*eighteen miles square.*" It was meant that it contained eighteen square miles. If the editor, when a school boy, had glanced

* We believe this statement was originally derived from some foreign magazine, perhaps Frazer's.

at a simple diagram, he would have learned, that in eighteen miles square there are 324 square miles.

Mistakes, equally gross with those above, are occurring by thousands every day, and all for the want of a familiar illustration of the elementary and fundamental principles of the common practical sciences. How few in our schools, or among farmers and mechanics, have a clear and distinct idea of what is meant by a cubic or solid inch, or foot, or mile! And until a person has a clear conception of that original elementary idea in solids, how can he move one step on the subject, except by groping in midnight darkness? And how is he to gain a conception of that idea, except by some familiar practical illustration?

Examples might be mentioned, almost without number, of wasted strength, and lost effort, both by children and adults, from the want of clear conceptions of a few elementary principles, which they might obtain by a glance even, at some appropriate illustrations: but we cannot add.

We have time only to remark, that the machinery of education is, in our opinion, important and necessary to encourage and invigorate effort, by giving the abstract principles light, and interest, and truth; and while used as a help merely for the operations and success of the more curious machinery of intellect and heart, it produces good; but the moment it is used as a dependence, it produces evil. And it is deeply to be regretted that, like most other good things, both in the external and internal world, it is often so abused as to become an evil, rather than a blessing.

Of the Orders of Architecture. [Continued from page 8.]

IONIC ORDER.—The origin of the Ionic Order is problematical. Vitruvius reports it to have been made in representation of the curls in the head-dress of females; but other hints are quite as probable, such as the spiral shape of the horns of rams, or that assumed by the barks of some trees, when dried in the sun, or the beautiful spiral forms of some sea shells.*

In the *architrave* and *frieze* of this order, all appearances of triglyphs and guttæ are omitted; and in the *cornice*, instead of the bold mutules of the Doric order, the ends

* This part of the order is called the *volute*, and forms the principal characteristic and ornament of the Ionic Order. It is also used in the Composite Order.

of smaller pieces of wood, to which the covering tiles were fixed, are represented by what are termed *dentils*, or *teeth*. This order differs also from the Doric, by having a *base* at the lower extremity of the shaft; the propriety of this might have arisen from the diameter of the shaft being much less than that of the Doric, in proportion to the height of the order, or the weight it had to sustain.

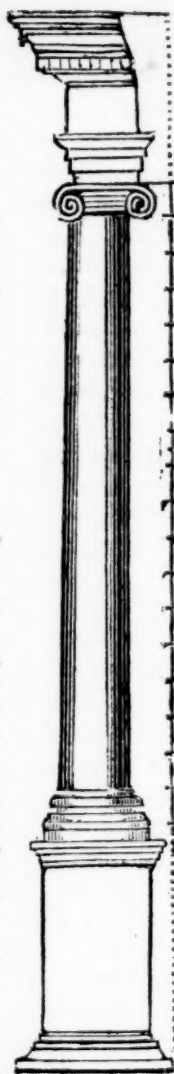
The rest of the Ionic order is not so precisely defined, nor so uniformly adhered to, as similar parts of the Doric.

In all the Greek Ionics, the height of the cornice, measured from the lower edge of the corona upwards, appears to have a constant ratio to the total height of the entablature, viz. nearly as 2 to 9, which seems the true one to accord with the character of the order. The great recess of mouldings, under the corona, gives it a striking prominence, and prevents the cornice from appearing too heavy, tho' both the dentile band and *cymatium* of the frieze are introduced under it.

On account of the frieze being wanting in most of the Asiatic remains, although the architrave and cornice have been accurately measured, the height of the entablature cannot be ascertained. The only instance in which a frieze has been discovered is in the theatre of Laodicea; and there it is rather less than one-fifth of the entablature. In the temple of Bacchus at Zeos, and Minerva Polias at Priene, the architraves are divided into three *facæ* below the *cymatium*. Their proportions are very different from those at Athens, though also elegant in character and effect.

The *height* of the Ionic columns was originally *eight* diameters, taken at the bottom; but the moderns have increased it to *nine*.

The shaft is generally cut into 24 flutes, with as many fillets. The altitude of the entablature may, in general, be two diameters; but it may be increased, and should not be less than one-fourth of the height of the column in works of magnificence.



It is said that the temple of Diana at Ephesus, the most celebrated edifice of all antiquity, was of this order. At present it is much used in churches, courts of justice, and buildings connected with the arts of peace.

CORINTHIAN ORDER.—This order is said to have been introduced in the fourth century before the Christian era, by Scopas, who employed it in the upper range of columns in the ancient temple of Minerva, at Tega. —Vitruvius, however, ascribes the invention of the Corinthian capital to Callimachus, who is said to have been an Athenian sculptor, contemporary with Phidias, about 540 B. C.

In all the examples of Stuart's Athens, this order has an attic base; the upper fillet of the trochilus or scotia projects as far as the upper torus.

Vitruvius observes that the shaft has the same proportions as the Ionic, except the difference that arose from the greater height of the capital, it being a whole diameter, whereas the Ionic is only two-thirds of it. But this column, including the base and capital, has, by the moderns, been increased to ten diameters in height. If the entablature is enriched, the shaft should be fluted. The number of flutes and fillets are generally 24; and frequently the lower one-third of the height has

cables or reeds, husks, spirally twisted ribbands, or some sort of flowers, inserted on them.

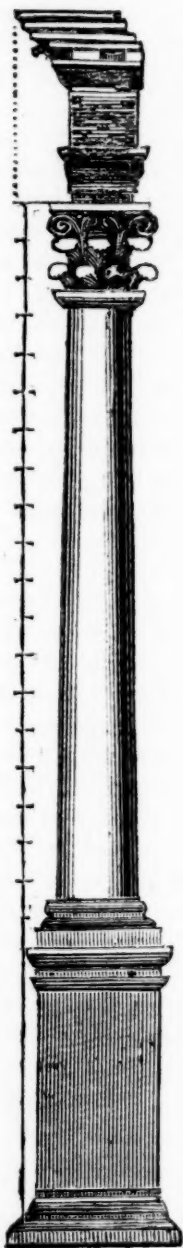
The great distinguishing feature of this order is its *capital*, which has for 2000 years been acknowledged the greatest ornament of this school of architecture. The height is *one* diameter of the column, to which the moderns have added *one-sixth* more.—The body, or nucleus, is in the shape of

a bell, basket, or vase, crowned with a quadrilateral abacus, with concave sides, each diagonal of which is equal to two diameters of the column. The lower part of the capital consists of two rows of leaves, eight in each row; one of the upper leaves fronting each side of the abacus. The height of each row is one-seventh, and that of the abacus one-eighth, of the whole height of the capital. The space which remains between the upper leaves and the abacus is occupied by little stalks, or slender caulicolæ, which spring from between every two leaves in the upper row, and proceed to the corners, and also to the middle of the abacus, where they are formed into delicate volutes. The sides of the abacus are moulded, and the curves of the sides are continued until they meet in a sharp horn or point. In the attic capital, the small divisions of the leaves were pointed in imitation of the acanthus. In Italy they most generally resembled the olive.

It may be observed generally, in the Greek Corinthian, that the volutes terminate in a point in the natural spiral, without either coiling round a circular eye, or bending backwards in a serpentine form, as in most of the Roman specimens.

This order seems never to have been much employed in Greece before the time of the Roman conquest; but this powerful people employed it almost exclusively in every part of their extensive empire; and it is accordingly in edifices constructed under their influence, that the most perfect specimens are found.

Of the celebrated modern architects who have treated of this order, Palladio makes the column $9\frac{1}{2}$ diameters high, one-fifth of which he gives to the entablature, consisting of a cornice with modillions and dentils, a flat frieze, and an architrave with three faciæ, divided by astragals; the base is attic. The design of Scamozzi bears a general resemblance to that of Palladio, but his column has ten diameters in its altitude; his entablature is one-fifth of this height; the cornice has modillions, the architrave consists of three faciæ, divided by astragals, and the base is attic. Serlio, following Vitruvius, has given this order an Ionic entablature, with dentils, and the same proportion of the capital; his column is nine diameters high, and has a Corinthian base. Vignola's Corinthian is a grand and beautiful composition, chiefly imitative of the three columns. He makes the column ten diameters and a half



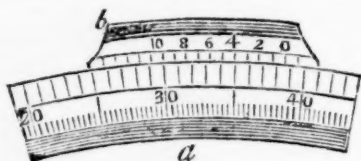
in height; the entablature is a fourth of that altitude; the cornice has modillions and dentils, the frieze is plain, the architrave of three faciæ, divided by mouldings, and the base is attic.

Sir William Chambers has observed, that “the Corinthian order is proper for all buildings where elegance, gaiety, and magnificence, are required. The ancients employed it in temples dedicated to Venus, Flora, Proserpine, and the nymphs of fountains; because the flowers, foliage, and volutes, with which it is adorned, seemed well adapted to the delicacy and elegance of such deities.”

ON THE VERNIER SCALE.—The method of dividing what is termed a vernier scale is founded on the difference of two approximating scales, one of which is moveable and the other fixed.

Thus, if a given space on the limb of an instrument be divided into any number of equal parts, and an equal space on an attached moveable scale be divided into *one more* part, it is evident that each of them will be smaller than the former, by that part of one division into which this attached sliding scale is divided.

Therefore, on shifting the attached scale forward, the quantity of aberration, or difference, will diminish at each successive division, till a new coincidence again takes place, and then the number of divisions on the sliding scale will mark the fractional value of the displacement, which will be equal to one of the divisions on the *vernier* or sliding scale.



Thus, in the annexed figure, *nine* divisions of the primary, or fixed scale, *a*, occupy a space equal to ten on the sliding scale, *b*, and the moveable *zero* stands beyond the thirty-eighth and thirty-ninth division; therefore, to find how much more than one whole division is indicated by the vernier, it is only necessary to observe where the opposite sections or lines on the scales coincide, which, in this instance, is opposite to the fourth division of the vernier, or sliding scale. The whole quantity is therefore 38.1.

It is evident that any *fractional* part of a whole division, on a primary or fixed scale, must bear the same proportion to an equal space on the vernier as a *whole* division, or

the space occupied by the whole divisions of the vernier.

Hence, one division of the vernier is always equal in value to the quotient of the smallest division on the primary scale, divided by the number of divisions on the vernier.

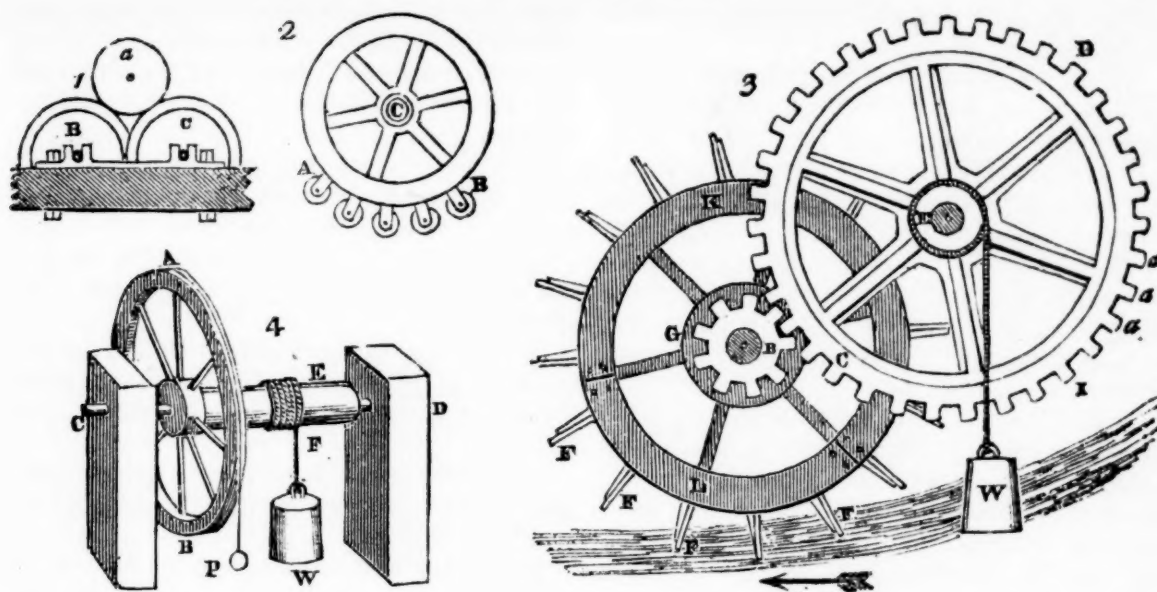
Thus, suppose one degree on the limb of a Hadley's quadrant to be divided into three equal parts, and that the attached vernier is divided into twenty equal parts: then one division on the vernier indicates one minute, for the third part of a degree is twenty minutes, which, divided by *twenty*, the number of divisions on the vernier, quotes *one* minute.

Hence, we have the following simple rule for ascertaining the value of one division of any vernier, attached to a primary scale.

Find the value of the smallest division on the primary scale, and divide this value by the number of divisions on the vernier, and the quotient will be the value of one division on the vernier of the same denomination, as that to which the smallest on the primary scale was reduced, previous to dividing by the divisions on the vernier.

DR. FRANKLIN.—The leading property of Dr. Franklin's mind, great as it was—the faculty, which made him remarkable, and set him apart from other men—the generator, in truth, of all his power,—was GOOD SENSE—only plain, good sense—nothing more. He was not a man of genius: there was no brilliancy about him; little or no fervor; nothing like poetry, or eloquence; and yet, by the sole, untiring, continual operation of this humble, unpretending quality of the mind, he came to do more in the world of science—more in council—more in the revolution of empires—(uneducated, or self-educated, as he was)—than five hundred others might have done: each with more genius, more fervor, more eloquence, and more brilliancy.—[Blackwood's Magazine.]

BOOKS.—Let us consider how great a commodity of doctrine exists in books; how easily, how secretly, how safely, they expose the nakedness of human ignorance without putting it to shame. These are the masters who instruct us without rods and ferules, without hard words and anger, without clothes or money. If you approach them, they are not asleep; if investigating, you interrogate them, they conceal nothing; if you mistake them, they never grumble; if you are ignorant, they cannot laugh at you.—[Philobiblion, by Richard de Bury.]



To contrive a Proper Machine that shall move a Given Weight with a Given Power, or, with a Given Quantity of Force, shall overcome any other Given Resistance. [From Emerson's Principles of Mechanics.]

If the given power is not able to overcome the given resistance, when directly applied, that is, when the power applied is less than the weight or resistance given, then the thing is to be performed by the help of a machine made with *levers, wheels, pullies, screws, &c.*, so adjusted, that when the weight and power are put in motion on the machine, the velocity of the power may be at least so much greater than that of the weight, as the weight and friction of the machine, taken together, is greater than the power. For on this principle depends the mechanism or contrivance of mechanical engines, used to draw or raise heavy bodies, or overcome any other force. The whole design of these being to give such a velocity to the power in respect of the weight, as that the momentum of the power may exceed the momentum of the weight. For, if machines are so contrived that the velocities of the agent and resistant are reciprocally as their forces, the agent will just sustain the resistant; but, with a greater degree of velocity, will overcome it. So that, if the excess of velocity in the power is so great as to overcome all that resistance which commonly arises from the friction or attrition of contiguous bodies, as they slide by one another, or from the cohesion of bodies that are to be separated, or from the weights of bodies to be raised, the excess of the force remaining, after all these resistances are overcome, will produce an acceleration of

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motion proportional thereto, as well in the parts of the machine, as in the resisting body. Now, how a machine may be contrived to perform this to the best advantage will appear from the following rules:

1. Having assigned the proportion of your power and the weight to be raised, the next thing is to consider how to combine levers, wheels, pullies, &c., so that, working together, they may be able to give a velocity to the power, which shall be, to that of the weight, something greater than in the proportion of the weight to the power. This done, you must estimate your quantity of friction, by the last prop.; and if the velocity of the power be to that of the weight still in a greater proportion than the weight and friction taken together is to the power, then your machine will be able to raise the weight. And note, this proportion must be so much greater, as you would have your engine work faster.

2. But the proportion of the velocity of the power and weight must not be made too great neither. For it is a fault to give a machine too much power, as well as too little; for if the power can raise the weight, and overcome the resistance, and the engine perform its proper effect in a convenient time, and works well, it is sufficient for the end proposed. And it is in vain to make more additions to the engine, to increase the power any further; for that would not only be a needless expense, but the engine would lose time in working.

3. As to the power applied to work the engine, it may be either a living power, as men, horses, &c., or an artificial power, as a

spring, &c., or a natural power, as wind, water, fire, weights, &c.

When the quantity of the power is known, it matters not, as to the effect, what kind of power it is. For the same quantity of any sort will produce the same effect; and different sorts of powers may be applied, in an equal quantity, a great variety of ways.

The most easy power applied to a machine is weight, if it be capable of effecting the thing designed. If not, then wind, water, &c., if that can conveniently be had, and without much expense.

A spring is also a convenient moving power for several machines; but it never acts equally, as a weight does; but is stronger, when much bent, than when but a little bent, and that in proportion to the degree of bending, or the distance it is forced to. But springs grow weaker by often bending, or remaining long bent; yet they recover part of their strength by lying unbent.

The natural powers, wind and water, may be applied with vast advantage to the working of great engines, when managed with skill and judgment. The due application of these has much abridged the labors of men; for there is scarce any labor to be performed, but an ingenious artificer can tell how to apply these powers to execute his design, and answer his purpose. For any constant motion being given, it may, by a due application, be made to produce any other motions we desire. Therefore, these powers are the most easy and useful, and of the greatest benefit to mankind. Besides, they cost nothing, nor require any repetition or renewing, like a weight or a spring, which require to be wound up. When these cannot be had, or cannot serve our end, we have recourse to some living power, as men, horses, &c.

4. Men may apply their strength several ways, in working a machine. A man of ordinary strength, turning a roller by the handle, can act for a whole day against a resistance equal to 30 lbs. weight; and, if he works ten hours in a day, he will raise a weight of 30 lbs. $3\frac{1}{2}$ feet in a second; or, if the weight be greater, he will raise it so much less in proportion. But a man may act, for a small time, against a resistance of 50 lbs., or more.

If two men work at a windlass, or roller, they can more easily draw up 70 lbs. than one man can 30 lbs., provided the elbow of one of the handles be at right angles to that of the other. And, with a fly or heavy wheel

applied to it, a man may do one-third part more work, and, for a little while, act with a force, or overcome a continual resistance, of 80 lbs., and work a whole day when the resistance is but 40 lbs.

Men used to carrying, such as porters, will carry, some 150 lbs., others 200 or 250 lbs., according to their strength.

A man can draw about 70 or 80 lbs. horizontally; for he can but apply about half his weight.

If the weight of a man be 140 lbs. he can act with no greater a force in thrusting horizontally, at the height of his shoulders, than 27 lbs.

As to horses: A horse is, generally speaking, as strong as five men. A horse will carry 240 or 270 lbs.

A horse draws to greatest advantage when the line of direction is a little elevated above the horizon, and the power acts against his breast; and can draw 200 lbs. for eight hours in a day, at two miles and a half in an hour. If he draw 240 lbs. he can work but six hours, and not go quite so fast. And, in both cases, if he carries some weight, he will draw better than if he carried none. And this is the weight a horse is supposed to be able to draw over a pulley, out of a well. In a cart, a horse may draw 1000 lbs.

The most force a horse can exert is when he draws something above a horizontal position.

The worst way of applying the strength of a horse is to make him carry or draw up hill. And three men, in a steep hill, carrying each 100 lbs., will climb up faster than a horse with 300 lbs.

Though a horse may draw in a round walk of 18 feet diameter, yet such a walk should not be less than 25 or 30 feet diameter.

5. Every machine ought to be made of as few parts, and those as simple as possible, to answer its purpose; not only because the expense of making and repairing will be less, but it will also be less liable to any disorder. And it is needless to do a thing with many, which may be done with fewer parts.

6. If a weight is to be raised but a very little way, the lever is the most simple, easy, and ready machine. Or if the weight be very great, the common screw is most proper. But if the weight is to be raised a great way, the wheel and axle is a proper power, and blocks and pullies are easier still; and the same may be done by the help of the perpetual screw.

Great wheels, to be wrought by men or cattle, are of most use and convenience when their axles are perpendicular to the horizon; but if by water, &c., then it is best to have their axles horizontal.

7. As to the combination of simple machines together, to make a compound one: though the lever, when simple, cannot raise a weight to any great height, and, in this case, is of little service, yet it is of great use when compounded with others. Thus, the spokes of a great wheel are all levers, perpetually acting; and a beam fixed to the axis to draw the wheel about by men or horses, is a lever. The lever, also, may be combined with the screw, but not conveniently with pulleys, or with the wedge. The wheel and axle is combined with great advantage with pulleys. The screw is not well combined with pulleys; but the perpetual screw, combined with the wheel, is very serviceable. The wedge cannot be combined with any other mechanical power, and it only performs its effect by percussion; but this force of percussion may be increased by engines.

Pulleys may be combined with pulleys, and wheels with wheels; therefore, if any single wheel would be too large, and take up too much room, it may be divided into two or three more wheels and trundles, or wheels and pinions, as in clock-work, so as to have the same power, and perform the same effect.

In wheels with teeth, the number of teeth that play together in two wheels ought to be prime to each other, that the same teeth may not meet at every revolution. For, when different teeth meet, they by degrees wear themselves into a proper figure; therefore they should be contrived that the same teeth meet as seldom as possible.

8. The strength of every part of the machine ought to be made proportional to the stress it is to bear; and, therefore, let every lever be made so much stronger, as its length and the weight it is to support is greater. And let its strength diminish proportionally from the fulcrum, or point, where the greatest stress is, to each end. The axles of wheels and pulleys must be so much stronger, as they are to bear greater weight. The teeth of wheels, and the wheels themselves, which act with greater force, must be proportionally stronger; and in any combination of wheels and axles, make their strength diminish gradually from the weight to the power, so that the strength of every part be reciprocally as the velocity it has. The

strength of ropes must be according to their tension, and that is as the squares of their diameters. And, in general, whatever parts a machine is composed of, the strength of every particular part of it must be adjusted to the stress upon it. Therefore, in square beams, the cubes of the diameters must be made proportional to the stress they bear. And let no part be stronger or bigger than is necessary for the stress upon it; not only for the ease and well-going of the machine, but for the diminishing the friction. For all superfluous matter, in any part of it, is nothing but a dead weight upon the machine, and serves for nothing but to clog its motion. And he is by no means a perfect mechanic, that does not only adjust the strength to the stress, but also contrive all the parts to last equally well, that the whole machine may fail together.

9. To avoid friction as much as possible, the machine ought not to have any unnecessary motions, or useless parts; for a multiplicity of parts, by their weight and motion, increase the friction. The diameter of the wheels and pulleys ought to be large, and the diameters of the arbors or spindles they run on as small as can be consistent with their strength. All ropes and cords must be as pliable as possible, and for that end are rubbed with tar or grease; the teeth of wheels must be made to fit and fill up the openings, and cut in the form of epicycloids. All the axles, where the motion is, and all teeth where they work, and all parts that, in working, rub upon one another, must be made smooth; and, when the machine goes, must be oiled or greased. If a joint is to go pretty stiff and steady, rub a little grease upon it.

The axis *a* (fig. 1) of a wheel may have its friction diminished, by causing it to run on two rollers, *B C*, turning round with it, upon two centres.

Likewise, instead of the teeth of wheels, one may place little wheels, as *A B*, (fig. 2,) running upon an axis in its centre. And this will take away almost all the friction of the teeth. And, in lanterns or trundles, the rounds may be made to turn about, instead of being fixed.

In all machines with wheels, the axles or spindles ought not to shake, which they will do if they be too short; and their ends ought just to fill their holes.

When the teeth of a wheel are much worn away, it makes that wheel move irregularly about, increases the friction, and requires more force, and may cause the teeth of two

wheels to run foul upon one another, and to stop their motion, and endanger breaking the teeth. To prevent this, proper care should be taken to dress the teeth, and keep them to their proper figure.

10. When any motion is to be long continued, contrive the power to move or act always one way, if it can be done. For this is better and easier performed than when the motion is interrupted, and the power is forced to move, first one way and then another, because every new change of motion requires a new additional force to effect it. Besides, a body in motion cannot suddenly receive a contrary motion, without great violence; and the moving any part of the machine contrary ways by turns, with sudden jerks, tends only to shake the machine to pieces.

11. In a machine that moves always one way, endeavor to have the motion uniform.

12. But when the nature of the thing requires that a motion is to be suddenly communicated to a body, or suddenly stopped, to prevent any damage or violence to the engine by a sudden jolt, let the force act against some spring, or beam of wood, which may supply the place of a spring.

13. In regard to the size of the machine, let it be made as large as it can conveniently. The greater the machine, the exacter it will work, and perform all its motions the better. For there will always be some errors in the making, as well as in the materials, and, consequently, in the working of the machine. The resistance of the medium in some machines has a sensible effect. But all these mechanical errors bear a less proportion to the motion of the machine in great machines than in little ones, being nearly reciprocally as their diameters, supposing they are made of the same matter, and with the same accuracy, and are equally well finished. Therefore, in a small machine, they are more sensible, but in a great one almost vanish. Therefore, great machines will answer better than smaller, in all respects except in strength; for the greater the machine the weaker it is, and less able to resist any violence.

14. For engines that go by water, it is necessary to measure the velocity and force of the water. To get the velocity, drop in pieces of sticks, &c., and observe how far they are carried in a second, or any given time.

But if it flow through a hole in a reservoir, or standing receptacle of water, the velocity will be found from the depth of the hole below the surface.

Thus, let $s = 16\frac{1}{2}$ feet, v = velocity of the fluid per second. B = the area of the hole. H = height of the water; all in feet. Then the velocity $v = \sqrt{2sH}$; and its force = the weight of the quantity $\frac{vv}{2s} B$ or HB of water,

or $= \frac{62\frac{1}{2}}{112} HB$ hundred weight; because a cubic foot is $= 62\frac{1}{2}$ lbs. avoirdupois. Also, a hogshead is about $8\frac{1}{2}$ feet, or 531 lbs. and a tun is four hogsheads.

When you have but a small quantity of water, you must contrive it to fall as high as you can, to have the greater velocity, and, consequently, more force upon the engine.

15. If water is to be conveyed through pipes to a great distance, and the descent be but small, so much larger pipes must be used, because the water will come slow. And these pipes ought not to be made straighter in some places than others; for the quantity of water conveyed through them depends upon the bigness of the bore at the straightest place.

Pipes of conduct coming directly from an engine, should be made of iron, with flanches at the ends to screw them together, with lead between, or else of wood; for lead pipes will bulge out at every stroke of the engine, and burst; but pipes next a jet must be lead. Pipes should not turn off at an angle, but gradually in a curve; pipes of elm will last twenty or thirty years in the ground; but they must be laid so deep that the frost may not reach them, or else the water must be let out, otherwise the frost will split them.

The thickness of any pipe must be as the diameter of the bore, and also as the depth from the spring. For a lead pipe of 6 inches bore, and 60 or 70 feet high, the thickness must be half an inch; and in wooden pipes, 2 inches.

Water should not be driven through pipes faster than four feet per second, by reason of the friction of the tubes. Nor should it be much wire-drawn, that is, squeezed through smaller pipes; for that creates a resistance, as the water-way is less in narrow pipes.

And in pump work, where water is conveyed through pipes to higher places, the bores of the pipes should not be made too straight upwards, for the straighter they are near the top, the less water will be discharged; nor should the pipe that brings the water into the pump be too straight, for the same reason. The wider these are, the easier the pump works.

When pipes are wind bound, that is, when

air is lodged in them that the water can hardly pass, it must be discharged thus: Going from the spring till you come to the first rising of the ground, dig it open till the pipe be laid bare; then, with a nail driven into it at the highest part, or rather a little beyond, make a hole in the top, and all the air will blow out at the hole, and when the water comes, batter up the hole again. Do the same at every eminence, and all the air will be discharged. If the water runs fast through the pipes, the air will be beyond the eminence; but stopping the water, the air will ascend to the highest part. If air be driven in, at first, along with the water, the nail-hole must be left open, or a cock placed there to open occasionally. Sometimes a small leaden pipe is placed over the other, communicating with it in several places, in which is a cock at top, to open upon occasion.

16. When any work is to be performed by a water-wheel moved by the water running under it, and striking the paddles or laddle boards, (fig. 3,) the channel it moves in ought to be something wider than the hole of the adjutage, and so close to the floats on every side, as to let little or no water pass; and when past the wheel, to open a little, that the water may spread. It is of no advantage to have a great number of floats or paddles, for those past the perpendicular are resisted by the back water, and those before it are struck obliquely. The greatest effect that such a wheel can perform, in communicating any motion, is when the paddles of the wheel move with $\frac{1}{3}$ the velocity of the water; in which case, the force upon the paddles is $\frac{1}{3}$ only, supposing the absolute force of the water against the paddles, when the wheel stands still, to be 1. So that the utmost motion which the wheel can generate, is but $\frac{1}{2}$ of that which the force of the water against the paddles at rest would produce. This is when the wheel is at the best; but, oftentimes, far less is done.

Machines to raise water, when well made, seldom lose less than $\frac{1}{3}$ the computed quantity of water to be raised. The best contrived engine is scarce $\frac{1}{3}$ part better than the worst contrived engine, when they are equally well executed.

A man with the best water engine cannot raise above one hogshead of water in a minute, 10 feet high, to work all day.

17. When a weight is to be raised with a given corporeal power, by means of the wheel and axle, so that the weight may receive the greatest motion possible in a given

time, the radius of the wheel and axle, and the weight to be raised, ought to be so adjusted, that the radius of the axle (EF) : (fig. 4) may be to the radius of the wheel (AB) : : as $\frac{2}{3}$ the power (P) : to the weight to be raised (W) : or, which comes to the same thing, the velocity gained by the power in descending must be $\frac{2}{3}$ of the velocity which would be gained by gravity in the same time.

This only holds good when the power is a heavy body, as well as the weight; but does not take place when the power is some immaterial active force, such as that of an elastic medium, the strength of a spring, &c., whose weight is inconsiderable.

18. *These principles, also, are very useful and necessary to be known, where water-works are concerned.*

The pressure of the atmosphere upon a square inch is 14.7 lbs. *avoird.* at a medium.

The weight of a column of water, equal to the weight of the atmosphere, is $11\frac{1}{4}$ yards.

A cubic foot of water weighs $62\frac{1}{2}$ lbs. *avoird.* and contains 6.128 *ale gallons*.

An ale gallon of water contains 282 inches, and weighs 10.2 lbs. *avoird.*

A tun of water, ale measure, weighs 1.1 *tun avoird.*, at 63 gallons the hogshead.

A cylinder of water a yard high, and d inches in diameter, contains $\frac{1}{16}$ *dd ale gallons*, and weighs $\frac{1}{16}$ *dd pounds avoird.*

SCIENCE AND LEARNING.—The noblest employment of the mind of man is the study of the works of his Creator.

To him whom the science of nature delighteth, every object bringeth a proof of his God; and every thing that proveth this, giveth cause of adoration.

His mind is lifted up to heaven every moment; his life is one continual act of devotion.

Casteth he his eyes towards the clouds, findeth he not the heavens full of wonders? Looketh he down to the earth, doth not the worm proclaim to him—Could less than Omnipotence have formed me?

While the planets perform their courses—while the sun remaineth in his place—while the comet wandereth through the liquid air, and returneth to his destined road again—who but thy god, oh man! could have formed them? what but infinite wisdom could have appointed them their laws?

Behold how awful their splendor! yet do they not diminish: lo! how rapid their motion; yet one runneth not in the way of another.

HEATING OVENS WITH MURIATE OF LIME.
—A safe fluid for conveying a high degree of heat in tubes not hermetically sealed is muriate of lime, now most successfully applied by Dr. Ure for boiling sugar. We had an opportunity lately of examining the whole of this process, which was most lucidly explained to us by Dr. Ure; and we are satisfied that all the bakers' ovens in London might be heated on the same principle as the sugar-boiler which we saw, with immense advantages both to the bakers and to the public. We do not however think it applicable to the heating of hot-houses under ordinary circumstances, which is a sufficient reason for the brevity of our remarks. We have shown, in our *Encyclopædia of Cottage Architecture*, how much has been done by Mr. Hicks in the construction of ovens, and in the production of an excellent and cheap bread; and also how much reformation is wanted in the formation of the common ovens of bakers.—[*Loudon's Magazine*.]

FLYING.—The act of flying is performed in the following manner: The bird first launches itself in the air either by dropping from a height or leaping from the ground; it raises up at the same time the wings, the bones of which correspond very closely to those of the human arm; the place of the hand, however, being occupied by only one finger. It then spreads out the wings to their full extent in a horizontal direction, and presses them down upon the air; and by a succession of these strokes the bird rises up in the air with a velocity proportioned to the quickness with which they succeed each other. As the intervals between the strokes are more and more lengthened, the bird either remains on the same level or descends. This vertical movement can only be performed by birds whose wings are horizontal, which is probably the case with the lark and quail. When birds fly horizontally, their motion is not in a straight line, but obliquely upwards, and they allow the body to come down to a lower level before a second stroke is made by the wings, so that they move in a succession of curves. To ascend obliquely, the wings must repeat their strokes upon the air in quick succession, and in descending obliquely, these actions are proportionally slower. The tail in its expanded state supports the hind part of the body: when it is depressed while the bird is flying with great velocity, it retards the motion; and by raising the hinder part of the body, it depresses

the head. When the tail is turned up, it produces a contrary effect, and raises the head. Some birds employ the tail to direct their course, by turning it to one side or the other in the same manner as a helm is used in steering a ship. We may observe that there is a peculiarity in the bones of birds which serves to lighten their bodies and greatly to facilitate their motions. A considerable portion of the skeleton is formed into receptacles for air, the interior of most bones in adult birds being destitute of marrow, and containing air-cells, which communicate with the windpipe or the mouth. In young birds the interior of the bone is filled with marrow, which, however, becomes gradually absorbed to make room for the admission of air. This gradual expansion of the air-cells, and absorption of the marrow, can nowhere be observed so well as in young tame geese, when killed at different periods.

Flying is not confined to those inhabitants of the air which have wings composed of feathers; there are many of these whose bodies are so light as not to require wings made of such strong materials, and which have them composed of thin membranes of the slightest texture. This is the case with all flying insects. The *Bat*, which belongs to the class *Mammalia*, is supplied with a kind of wing peculiar to itself, which may be considered as an intermediate link between the wings of birds and those of other animals.

The bat's wings are formed of membranes spread upon the bones, which correspond to those of the arm, fore-arm, and hand, in man, and of the fore-leg in quadrupeds. So far they resemble those of birds; they differ, however, in the materials of which they are composed, and in the bones bearing a closer resemblance to those of the human hand. They have what is peculiar to themselves, a hook-like process attached to the bone of the wing, by which they lay hold and support themselves upon the cornices of buildings, and so far employ their wings as hands. These wings, when extended, are of great length. In the larger species found in some parts of India, Africa, and South America, celebrated under the name of *Vampyres*, they often measure five feet; and Sir Hans Sloane was in possession of a specimen brought from Sumatra, the wings of which measured seven feet. As the bat itself is not rendered buoyant by any of the means employed in the internal structure of birds, and as its wings are themselves membranes of some strength, great extent of surface is

required in them: they are not, however, fitted for long flight, and must be considered as a very remarkable deviation from the structure of the bird on one part, and from that of the quadruped on the other. The only regularly formed quadruped that has the power of flying is the *Flying Squirrel*. The substitute for wings in this animal is a broad fold of the integument spread out on each side of the body, and attached to the fore and hind legs, reaching as far as the feet; so that, by stretching out its feet, it spreads this fold and keeps it in an extended state, in which it has a nearer resemblance to a parachute than a wing. Some species of lizards and fishes are also furnished with substitutes for wings, by which they are enabled to support themselves in the air, and fly for short distances. In the *Flying Fish* the substitute consists of a simple elongation of the pectoral fins, to a sufficient extent to support the animal's weight—in this respect corresponding with the wings of birds, since the pectoral fin of fishes is analogous to the anterior extremity of the other classes.

HUMAN AND ANIMAL SENSATION.—When the epicurean ransacks the three kingdoms of nature in all their provinces, and even presses in putrefaction itself, to give a flavor to his mess, he has actually less animal pleasure in that mess than the rustic has in a crust of wholesome brown bread, or a potato nicely roasted in the turf ashes. His sensation may be different, but it is not better; and let a man be but hungry enough, and give him something to appease that hunger, and all the cooks that "the devil ever sent" to mar Heaven's bounty can give no more enjoyment. So also in drinks—wines have their gusto, and other potations their exhilaration; but "Adam's wine," as in wells living from the rock, free from foreign substances, and showing every gem of the casket in each drop, is, in truth, and will remain "the liquor of life." The weary, the fainting, and the dying, call not for burgundy, or champaign, or tokay; the longing of their heart, the hope of their recovery, or the alleviation of their anguish, is "water,"—water clear from the fountain, or fresh from the cistern. Thus we see that, even in those cases in which art and luxury have done the most, human nature, when it comes to the hour of tribulation—to the moment of peril—to the article of strife with nothingness—clings to the freshness and simplicity of nature. And it is even so in every thing. When cold sweat

bedews the temples of the monarch—when artery and vein have forsaken each other, and the curdling fluid is breeding corruption in the little capillary tubes between—when the heart's feeble pulse is flung back upon it by the dying vessels, and it is about to be broken by its very strength—when the lungs will no longer remove the charcoal, but make, as it were, the fire of life to smoulder in its own ashes—when the currentless throat begins to be choked up by its own refuse—when the angel of death stands ready to loosen the "silver cord," and break the "wheel at the cistern, and the pitcher at the fountain,"—what then recks the monarch for his state and his diadems! Cast aside that sceptre, it is a bauble; doff that crown, it is nothing; rend away the velvet and the tinsel, they are trash; remove that coverlet of satin, it is a burden: give him the fresh air of heaven—the first draught of nature that he drew—so that the king may die easily and in peace; free the monarch of all the trappings of his grandeur—so that the spirit of the man may mount in triumph to its God.—[Mudie.]

EQUALITY OF MANKIND.—All civil distinctions disappear before a thing being. He sees the same passions, the same ideas, pervade the mind of the peer and the peasant; a gloss only is discernible in the language and appearance of the one, which the other does not possess. If any difference distinguishes them, it is to the advantage of him who wears the mask. The people show themselves as they are, and they are not amiable; the great know the necessity of disguising themselves; were they to exhibit themselves as they are, they would excite horror.—[Swift.]

RAILROADS.—The number and extent of new lines of railroad now in progress and in contemplation have caused a considerable rise in the price of iron. In addition to those now forming in England, very large orders have arrived from America. In one instance, near Wolverhampton, we have heard of an order to the amount of several thousand pounds for cast iron chairs alone.

A magnificent undertaking is in contemplation by the French government—the formation of a grand line of railway from Paris to Rouen, Havre, Lyons, and Marseilles. The government, with this intent, have already demanded a vote of £20,000 for the preliminary survey.

This is part of a vote of £4,000,000 sterling just obtained for the completion of public edifices, monuments, canals, and roads.

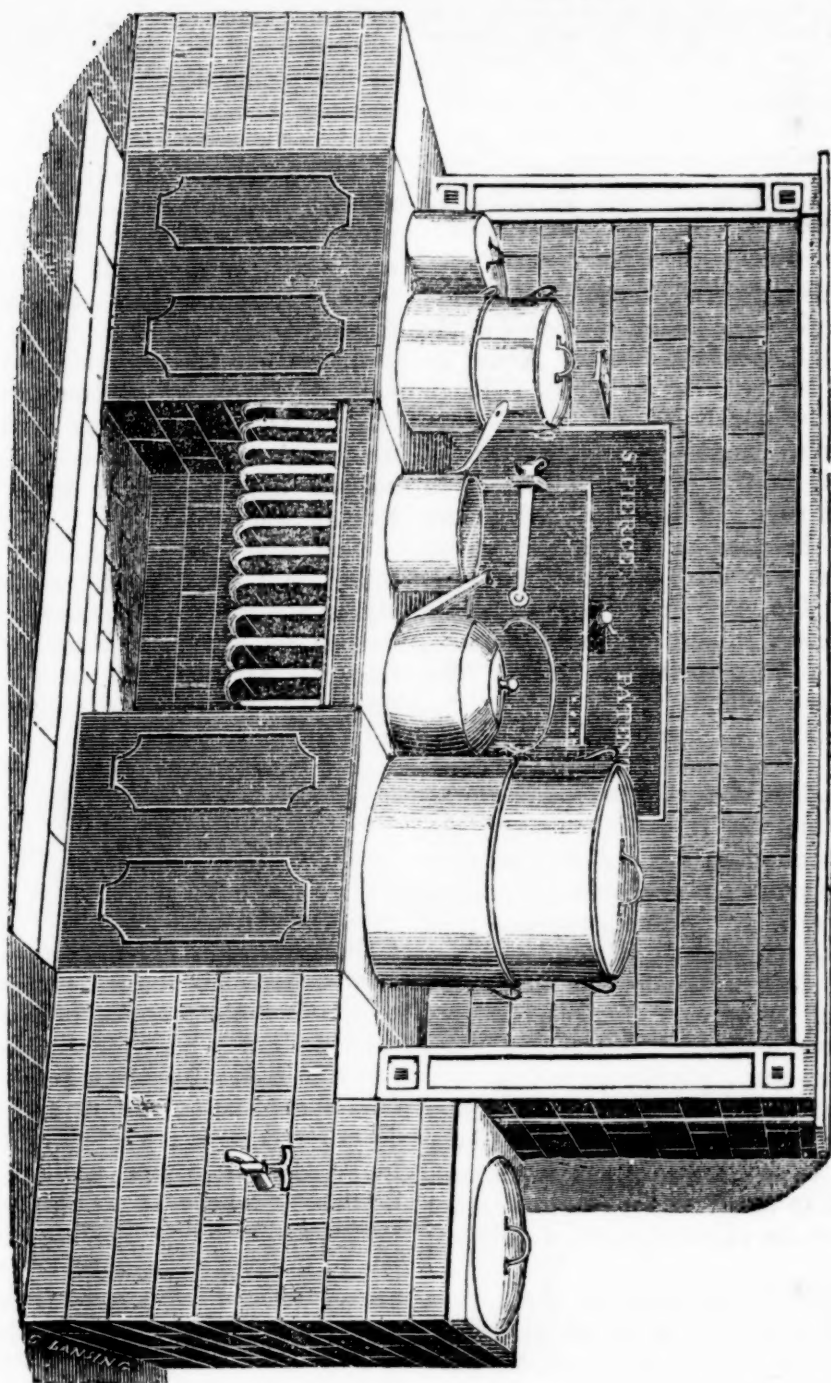
The heavy work of that great undertaking, the Newcastle and Carlisle Railway, on the line from Carlisle eastward, for about ten miles, is now in a state of considerable forwardness. The tremendous excavation at the Cawran hills is about half finished, and some idea may now be formed of the grand appearance which this portion of the road will present. The length of the cut is about 800 yards, the depth in many places at least 40, and consisting of 1,000,000 cubic yards of earth, sand, and stone.

Another heavy piece of work, three miles nearer Carlisle than the Cawran hills, is the viaduct of five arches, over Corbyneck Valley; it is now in a forward state, and is a handsome structure. Within 200 or 300 yards of this, is the stupendous viaduct over the river Eden, and the adjoining glen at Wetherall, to connect the lofty rocks on each side. This is a magnificent object: its entire length is 600 feet, and breadth 20 feet within the parapets; it has five arches of 80 feet span each. From Wetherall to within a mile and a half of Carlisle, the work is also in a state of forwardness. Nearer to Carlisle nothing of any consequence has been set about, with the exception of the bridge over the Petterel, near Maine's cotton works, which is now completed.—[London Repertory of Arts for July.]

THE VILLA OF FROMONT, ON THE SEINE.—M. Soulange Bodin combines, at Fromont, an elegant villa residence with an exotic nursery, and an institution for young horticulturists. M. Soulange Bodin, like M. Vilmorin, is at once a skilful cultivator, a marchand grenetier (seedsman,) a scholar, and an accomplished gentleman. As connected with the army, he has been all over Europe; and having been long (to use the Prince de Ligne's phrase) under the influence of the *jardinomanie*, wherever he went the gardens were the main objects of his attention. At one time he had the principal management of the gardens of the Empress Josephine, at Malmaison. On M. Bodin's retirement to Fromont, in 1814, he commenced laying it out in the English manner, and so as to combine the picturesque scenery of the park with the profitable culture of

the nursery. The grounds exceed a hundred acres of a surface gently varied, and sloping to the Seine. They are surrounded by a walk or drive, which displays varied views of the interior, the main feature of which is the chateau; and of the Seine, with some rising grounds beyond the boundary. In various spaces among the groups of trees are formed beds of peat earth, in which seedlings of American shrubs are raised; the more rare kinds being propagated by artificial methods. In the walled garden near the house are numerous pits and frames, in which the more popular exotics, such as the orange, Camellia, Azalea indica, and numerous other green-house and hot-house plants, are increased by hundreds. In effecting this, one of the principal modes employed is herbaceous grafting, or grafting on the young wood. The plants thus raised are sent to all countries. In the larger green-houses and hot-houses there is a collection of fine specimens, intended principally for ornament. The object of the institution for the instruction of young gardeners is to supply French country gentlemen with young men well acquainted with both the practice and the theory of their art in all its branches. For this purpose there are professors, a library, a museum of implements and models, and a monthly journal, entitled *Annales Horticoles de Fromont*. There is not a more striking example, in all France, of the gentleman and the man of science being united with the tradesman, than in M. Soulange Bodin; nor a villa in which more industry and activity goes hand in hand with picturesque beauty. There is nothing of the kind that we know of in England; nor can there be in the present state of things. It is, perhaps, one of the finest moral features in France, that most gentlemen are either manufacturers, tradesmen, or farmers; and that nearly all of the persons practising these professions are, in education and manners, gentlemen.—[London's Magazine.]

INFLAMMABLE SPRING.—In the township of Wales, 15 miles from Buffalo, near the bank of a small stream, there issues from a ledge of slate rock a stream of air, which, on the application of a torch, takes fire, and continues to burn till it is extinguished by the rising of the water of the rivulet. The flame is about 6 inches in length, and 2½ in diameter.



PIERCE'S KITCHEN RANGE AND COOKING APPARATUS.—Undoubtedly most of our readers bear in mind that stern winter has already, from the far north, commenced his journey for these quarters. We would remind them of what they have all very probably experienced, that he comes rapidly, and seldom fails of having to punish even the most prudent for not having been more diligent in timely preparations. We benevolently, therefore, advise them to hasten away to 201 Chamber street, New-York, and see what Mr. Pierce has to show them. In ad-

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dition to the conveniences exhibited in the cut, Mr. P. will point out to them many others, particularly additional boilers heated by tubes.

One serious objection to the common cooking stoves is, that they make the room too hot, rendering the inmates very liable to take dangerous colds, in passing suddenly and frequently from the kitchen into other apartments and into the open air.

We select the following from the recommendations published in Mr. P.'s circular:

NEW-YORK, August 1, 1833.

A Cooking Range and Grate for Anthracite Coal, con-

constructed by Mr. S. Pierce, has been in use in my house for more than two years. It has answered its purposes perfectly well, and besides proving much more convenient than the old method of cooking with wood, it has proved to be eminently economical.

EDW. DELAFIELD.

NEW-YORK, July 30, 1833.

Mr. S. Pierce has fitted a Kitchen Range and Cooking Apparatus, adapted to the use of Lackawana coal, in my kitchen, which I approve of very highly, and recommend to public patronage.

PHILIP HONE.

Notes on Mildew, from a Lecture on that Subject, by Professor Lindley, delivered at the Horticultural Society's Meeting Room, on the 24th of April. By J. W. L. [From Loudon's Gardener's Magazine.]

Dr. Lindley began by stating that he did not intend, on the present occasion, to give a regular series of lectures, as that plan required his hearers to attend the whole course, which very few individuals had leisure to do. He, therefore, now proposed to take a different subject for every lecture, and to make each complete in itself. His first subject was mildew.

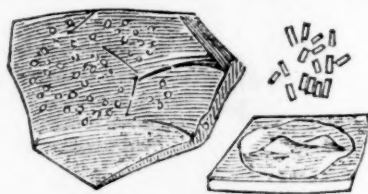
Every horticulturist has heard of mildew; and, though it is often confounded with blight, honey-dew, &c., the destructive fungi which constitute the real mildew, and the ravages they occasion, are unfortunately but too familiar to every one accustomed to either a garden or a field. Notwithstanding this, even the most eminent horticulturists know comparatively little either of the nature of this pest, or of its cure. One most important error exists respecting it, and this is the belief, common among gardeners and agriculturists, that one kind of mildew will infect several kinds of plants: but this can never be the case; each tribe of plants has a mildew peculiar to itself, which cannot, under any circumstances, affect plants of a different kind.

Mildew generally appears on the leaves or stems of plants in the form of red, white, or black spots, as a number of minute projections, as a frosty incrustation, or as a brownish powder; in every case spreading, more or less rapidly, according to its kind, and in its progress withering the leaves, destroying the fruit, and, finally, killing the plant. The popular reasons assigned for this pest are various; it has been ascribed to insects, fog, and even, in one agricultural report, to the inflammation of the oxygen gas in the air towards the end of summer, which scorched the leaves. These opinions have, however, been all proved to be erroneous. Mildew is nothing more than different kinds of fungi, or parasites, attacking

different kinds of plants, and varying in appearance and species according to the nature of the plants which they attack. It is the greatest enemy to the agriculturist, but the gardener also suffers from it severely.

The fungi, commonly called mildew, are divided into three classes: 1. Those which grow, or rather lie, on the surface of leaves, and which, perhaps, do not derive any nutriment from the plant; 2. Those which are formed in the interior of the stem or leaf, and protrude themselves from it when ripe; and, 3. Those which only attack the roots. All are extremely simple in their organization, and very minute in their forms; they seldom appear but in autumn, except in forcing-houses.

The first class, or mildew composed of those fungi that live on the surface of leaves, injure a plant by preventing its respiration, but do not appear to draw any nourishment from it. One of the most common of the fungi which attack the common cabbage is

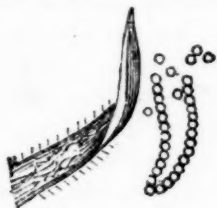


Cylindrosporium concentricum Grev. These very destructive fungi have the appearance of small white patches, or specks, of frosty incrustation, which, when magnified, are found to consist of a number of small cylinders, lying end to end, or across each other. These cylinders are all filled with seed, and burst when it is ripe, scattering it in every direction; wherever it falls upon the leaf it takes root, and thus the fungus spreads rapidly. The superficial mildew which attacks rose trees and many other flowering shrubs is a kind of *Uredo*. This name, derived from *uro*, Lat., to burn or scorch, is applied to those occasional discolorations of the surfaces of plants which were formerly attributed to blights, or injuries from the atmosphere, and which have the appearance of a brown powder. *Uredo effusa* Grev. generally shows



itself on the under sides of the leaves of the Rosaceæ, and spreads rapidly. *Uredo Ro-*

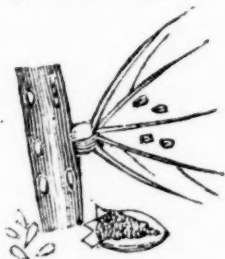
sæ Pers. is another kind, which also attacks rose trees. The fungus called *Acrosporium monilioides* consists of a number of globules,



attached to each other, which, when magnified, appear like the beads of a necklace, and in many cases are found standing upright. When ripe, these globules fall, and, taking root, form fresh strings, or necklaces, like the first. Sometimes little tufts of these globules appear fixed to stalks; and, from some fancied resemblance to the brushes used for sprinkling holy water, are called



Aspergillus. The superficial mildew which infects the onion, and is very fatal to that plant, is called *Botrytis*. Its name signifies a bunch of grapes; and it is thus called from a fancied resemblance between that fruit and its clusters of little globular seeds and seed-vessels. The bean and pea have a superficial mildew, (*Uredo Fabæ Pers.*) which



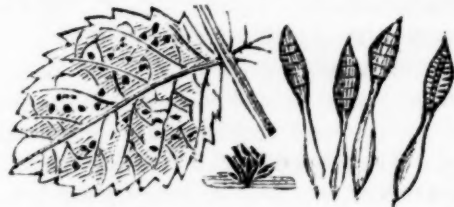
spreads along their leaves, like white roots curiously interlaced. From these roots spring a number of branch-like shoots, each bearing a ball-like head, or brown berry, which, when ripe, bursts, and discharges seed.

The second class of fungi, viz. those which spring from the interior of leaves, and stems, are by far the most fatal. These fungi generally appear in a sort of bag, or case, which is supposed to be formed of the cuticle of the affected leaf. The oak is attacked by a species of fungus, *Æcidium*, different varieties of which are found on many kinds of forest trees. The *Æcidium Pini*,

found on pine trees, has, when magnified, the appearance of a number of nine-pins. When ripe, the cuticle which covers the fungus bursts, and emits a powder of a bright orange color, which is the seed. A mildew of this kind, which infects corn, is highly injurious to the farmer. It is vulgarly called the pepper brand; and, when corn is attacked by it, it gradually consumes the substance of the grain, leaving in its stead only a dark powder, which has a very offensive smell. This fungus is found only on barley, and in this respect differs from the *Uredo Segetum*, or smut, which is destructive not only of barley, but also of wheat and oats. The *Uredo Segetum*, or smut, has been the subject of many interesting experiments by Mr. Bauer, of Kew, whose discoveries will, no doubt, throw very considerable light upon the subject. It not only destroys the grain, which it converts into a kind of jelly, but it attacks the leaves and stems, always forming in the interior of the plant, and bursting forth when ripe. Corn is also attacked by a species of *Puccinia*, a very fatal kind of fungus, which always appears divided into cells. *Puccinia Graminis*, which attacks corn, forms in the



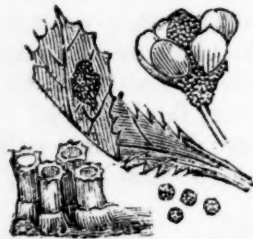
interior of the stalk, and, when ripe, bursts forth in clusters, like bunches of grapes, of a dark brown color. *Puccinia Rosæ Grev.*



appears on the leaves of rose trees, in little brown tufts, which, when opened and magnified, are found divided into extremely minute cells. A correspondent of this magazine mentions that his celery was infected with ferruginous spots, occasioned, no doubt,

by the *Puccinia Heraclei* Grev.; and another correspondent, Mr. Robert Errington, gives a detailed account of the manner in which his celery was attacked by the same disease, and of the means which he adopted for its cure. He describes his celery as having the appearance of having been scorched by fire. He says he dug up the infected plants, and buried them, but this only seemed to increase the evil; and he tried several other remedies, but without any permanent success.

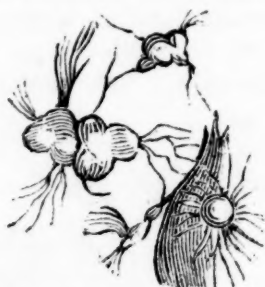
It is a vulgar error to suppose that a berberry tree (*Berberis vulgaris* L.), if planted in a corn field, will, if infected with mildew, communicate the disease to the corn. This cannot be the case, as the mildew which attacks the berberry is quite different from any of the fungi which are found on corn. The berberry mildew, when magnified, is found to consist of a number of small orange cups,



with white films over each. When ripe, these lids burst, and the top of the cup assumes a ragged uneven appearance, like white fungi. Each cup has within it a number of little boxes containing seeds. The mildew on the pear tree is called *Æcidium cancellatum*. It first appears like mucus, but consists of a number of hairy substances. These hairs, when magnified, appear like a collection of granules of a bulbous shape, each containing a number of balls connected by strings. These balls, though so minute as to be scarcely perceptible by the eye, are yet only receptacles for seed. This is a most destructive fungus: it always seizes on the veins of the leaves, which afterwards turn yellow and fall off; the branches next wither, and in two or three years a whole orchard is destroyed. Mr. Knight, in 1832, suffered severely from this fungus, and has tried many experiments respecting its cure. Hawthorn trees are attacked by a fungus which at first appears merely a point made by an insect, but afterwards looks like fungi (*Æcidium laceratum* Dec.) The sycamore fungus is a black spot, consisting of oblong purplish bodies, yellow inside, and containing tubes filled with seeds. *Æcidium Grosulariæ* Dec. attacks gooseberry bushes, and

Æcidium cornutum the mountain ash: both spread rapidly, and are very difficult to cure. The ergot on the rye is a well known and very destructive species of mildew. It partakes of the nature of the truffle, and grows out of a spike of corn like a prolonged kernel. It is long, horny, and cartilaginous; and it consists of fibres closely interlaced. This disease evidently originates in the centre of the stem. It affects maize, various species of grass, and is often found in plants of yellow gentian, &c.

The principal fungi of the third class, or those which attack the roots of plants, are two; and both closely resemble truffles. One of these (*Rhizoctonia Crocorum*), which is



of a brownish yellow, attacks crocuses; and in those countries where the crocus is cultivated for its saffron, as an article of commerce, it makes great ravages. It is called by the French *la mort du safran*, and soon destroys a whole crop. The other fungus, *Periola tomentosa*, is found on the potato, lucerne, &c. It turns the roots, which are naturally white, of a purplish hue. Its ravages are often attributed to grubs. Both these fungi appear to be propagated by spawn, or fibres which spread through the earth, and cling round the roots which they find in their way.

Having given a rapid sketch of some of the principal kinds of fungi which produce mildew, Dr. Lindley proceeded to speak of the causes which produce them, and of their cure. All are very easily propagated, from the rapidity with which they arrive at maturity, and the immense number of seeds which they produce. Most of the mildew fungi require only twenty-four hours from the first springing of the plant to the ripening of its seed; and the number produced by each may be guessed from the circumstance of one mushroom being sufficient to propagate 250,000,000. The extreme minuteness of the mildew fungi renders them still more numerous. The first class, or the superficial mildew, appears to be communicated by the air, the seeds when ripe being carried by it

from one plant to another, and establishing themselves wherever they touch. They destroy a plant by covering the surface of its leaves, and thus preventing respiration. Plants are generally most affected by superficial fungi after a long drought, when the fibres of their roots are unable to imbibe sufficient moisture from the soil, and the plant thus becomes debilitated, and affords an easy prey to the parasite which attacks it: as a proof, Dr. Lindley mentioned that in Scotland, where there are heavy night dews, this fungus is unknown. The cure seems to be abundant watering. Dr. Lindley mentioned a case of some onions, in the gardens of the Society at Chiswick, which were attacked by this fungus. These onions had been transplanted, and their roots were consequently so much weakened as to be unable to imbibe a sufficient quantity of moisture. Dr. Lindley had the plants abundantly watered, which, though it did not cure the infected plants, appeared completely to arrest the progress of the disease. Other onions, not transplanted, were not attacked. A correspondent of this magazine, Mr. Haycroft, recommends a mode of curing this mildew, which appears to be effectual, by cutting off the infected branches, washing the walls with a composition, and removing the infected nails, &c. Sulphur has also been recommended, but is not found to answer.

The internal mildew evidently cannot be communicated by the air, since it always appears to spring from the interior of the plant, and to be at first covered with a thin skin, from which it does not burst till it is ripe. It is impossible, therefore, that this kind of mildew can be communicated externally, and yet the fact that it is contagious is so clear as not to admit a doubt. The only manner in which it appears probable that it can reach the interior is through the roots. The seeds, when ripe, fall upon the earth, which becomes contaminated by them, and they are sucked up by the spongioles of the roots. Mr. Dovaston has also held this opinion. The correctness of this hypothesis is proved by sowing clean seeds in infected soil; and the young plants from these seeds springing up with the disease upon them. The circumstance of its always attacking the most vigorous plants is thus also explained, as it is evident that the more rapid the circulation the greater is the probability of extraneous substances being drawn up with the moisture imbibed by the roots. It is also clear that, in this case, water must ag-

gravate the disease; as, by exciting the plant to suck it up, it would increase the danger of the seeds of the fungi being drawn in with it. This was also the reason that Mr. Errington found that burying his celery roots only made the mildew spread more rapidly. The only cure for this fungus seems to be that adopted by Mr. Knight with his pear trees, viz., taking them up, washing the roots quite clean, from every particle of soil, and then replanting them in quite a different part of his grounds.

Red plants are said to be more liable to mildew than any other. Red is, indeed, supposed by some always to indicate a morbid action, as it shows that the plant is unable to absorb carbonic acid gas from the atmosphere, which is necessary to its perfect health; at all events, it is a proof of disease when leaves, or any other parts of a plant, not naturally red, assume that color. Other experiments have been made for curing, or at least preventing the spread of, the internal mildew; and Mr. Bauer has found that steeping grains of corn in lime-water will produce the desired effect. There appears no cure for mildew in the roots, but by cutting a deep trench round the infected plants, and cutting off all communication between them and the rest of the field.

THE PROGRESS OF INVENTION EXEMPLIFIED.—Many volumes have been written on the gradual refinements of language, and learned men have pointed out the immense stride in improvement which has arisen from an unimportant innovation, yet millions had spoken the imperfect language without dreaming of the simple means by which the finishing touches could be given to it. The effects also which have flowed from apparently the most simple contrivances are almost incredible; and should those who are familiar with their most perfect forms be but casual observers, they may be startled at the exaggerated terms in which their value may be estimated—or disgusted with the claims of some mechanic, who, by merely adding a wheel or pulley, or giving a trifling difference to their proportions, may, by these means, have been the first to make the machine efficient. The simple process of drawing a cork will furnish the necessary illustrations.

The inventor of bottles is unknown; but these were in use for centuries before corks were thought of, and these again were employed for generations before a convenient method was hit upon for their extrac-

tion. The exhilarating contents could then only be tasted by what is now technically called "be heading the bottle." More expert practitioners had many opportunities of shewing their skill in removing the impediment by a dexterous twist of the fingers;



or, if that were impracticable, teeth were called in as their natural auxiliaries; here, however, in many cases, it was doubtful whether the cork would follow the teeth, or the teeth remain in the cork; and if an obstinate remnant would remain, a nail



was a ready means of dislodging the stubborn plug, particle by particle,—when at any time, through an impatience of the nibbling labor, or a despair of accomplishing a clean extraction at all, it was resolved at once to send the obstacle the wrong way: this was then, indeed, an invaluable instrument. A pair of skewers, or forks, inserted "witch-wise," would sometimes accomplish those difficult cases which had baffled the exertions of all the naturals. Twisting the lower extremity of the "bare bodkin" into a spiral form, and adding a handle to it, was the thought of a master genius; and, in this shape, mankind, for ages, were contented to avail themselves of its services—and even at the present hour, some barbarous, uncouth countries and districts may be named where it is still the extractor in most general use. In our civilized land, it must be yet in the recollection of many, that this was, in numerous cases, a very inefficient machine; and the pleasure of beholding the generous beverage beaming through a crust of many years, was cruelly damped by the experience, that in proportion to the pains taken in fixing the cork, was the mental agony which must be endured during all attempts to remove it. Jovial fellows, who forget those days, in their moments of inspiration, may talk indeed of their Phillises, their Ianthes, their Delias, their Saccharissas, their Chloes, and their what-nots,—let them henceforth mingle a little gratitude with their admiration, and glorify a nymph greater than them all. Miss O'Rourke, like her own exquisite potteen punch, was a delightful com-



pound from ingredients, both mental and corporeal, of the most opposite nature. The friend of Kosciusko, and the authoress of the Rhapsody, which afterwards rung so often throughout the country to the favorite tune (Gramachree) of the patriot Pole,—such another hostess was not in England wide, and no other of her order ever conferred so great a benefit on bottle-suckers as she did, by her superlative invention of placing a button at the end of the screw-worm. Henceforth the decanting process was a mere matter of routine. When, in her green old age, Death laid his hand on the inventress, a piratical screw-

maker took to himself the credit and profit of the button addendum. Yet Miss O'Rourke shall never be forgotten, even although her master-piece, some few years later, was eclipsed, and may be yet superceded by the *King's Screw*, which can receive no addition either to its beauty or convenience, except it be probably some little steam appendage to make it self-acting.—[Stuart.]

CINNAMON STONE.—M. Laugier has found the massive cinnamon stone of Ceylon to be composed of silex 38, lime 33, alumine 19, ox. iron 7. He regards it as a silicate of lime and alumine, with an accidental portion of iron.—[Bull. Univ.]

An Elementary Treatise on Mechanics. From the French of M. BOUCHARLART: with Additions and Amendments, by EDWARD H. COURTENAY, Professor of Natural and Experimental Philosophy in the Military Academy, West-Point. New-York, J. & J. Harper, pp. 432.

This is a good translation of an excellent book, and will be found serviceable to the practical workman and the student. The translator has introduced some original matter, and has, as he states in his preface, deemed it necessary "to extend or modify several subjects where the method of investigation adopted by the author appears incomplete or obscure." It is intended as a text book for the use of the Cadets of the United States Military Academy. We hope it will meet with all the patronage it so well deserves.



METEOROLOGICAL RECORD, KEPT IN THE CITY OF NEW-YORK,

From the 1st to the 25th day of August, 1833, inclusive.

[Prepared for the Mechanics' Magazine and Register of Inventions and Improvements.]

Date.	Hours.	Thermometr.	Barometr.	Winds.	Strength of Wind.	Clouds from what direction.	Weather.
August 1..	6 a. m.	63	29.97	wsW	light	NW	fair
	10	68	29.98	..	..	..	..
	2 p. m.	76	29.93	..	..	..	..
	6	78	29.90	SW	..	..	..
	10	72	29.91	..	..	..	..
" 2..	6 a. m.	67	29.95	SW—wsW	..	..	cloudy
	10	74	29.98	..	..	WNW	fair
	2 p. m.	82	29.98	SW	..	W	showery —fair
	6	74	29.98	..	..	W by S	fair
	10	72	30.02	..	..	..	..
" 3..	6 a. m.	65	30.06	NE	..	ENE	.., and low scuds from ENE
	10	70	30.06	ENE—SSE	..	ENE—SE	..
	2 p. m.	78	30.05	SSW	..	..	clear —upper wind from SSE
	6	74	30.02	..	..	..	..
	10	70	30.03	E	..	..	..
" 4..	5 p. m.	71	30.02	SE—SSW	..	WSW	cloudy
	10	76	30.02	SSW	..	..	..
	2 p. m.	82	29.99	WSW	moderate	..	fair—cloudy at 4—rain and thunder
	6	72	30.02	WSW—WNW	..	..	rain
	10	70	30.03	NNW	light	..	cloudy —rain
" 5..	6 a. m.	68	30.04	NNE	faint	{ W by S } { E—SE }	cloudy—scuds from ENE
	10	76	30.05	E—SE	light	{ W by N } { SE }	fair —cloudy
	2 p. m.	82	30.05	SE	moderate	{ W by N } { WSW }	cloudy
	6	76	30.05	..	..	{ WSW }	..
	10	73	30.05	..	..	..	..
" 6..	6 a. m.	73	30.04	..	light	{ SW } { SE }	..
	10	78	30.05	SSE	moderate	{ SW } { SSE }	.. —rainy
	2 p. m.	73	29.99	..	gale	..	rain—thermometer falls at 5.30
	6	68	29.95	..	gale—strong	{ WSW } { S }	thunder and rain —cloudy
	10	67	29.98	..	moderate	..	cloudy
" 7..	6 a. m.	70	29.95	SW—NW	light	{ WSW } { NW }	fair —cloudy
	10	78	29.98	NW—WSW	..	..	..
	2 p. m.	82	29.97	SW	..	WSW	..
	6	73	29.97	SSW	..	..	..
	10	75	30.00	..	..	..	clear
" 8..	6 a. m.	68	30.08	NNW	moderate	WSW	fair
	10	72	30.10	NW—N	..	..	.. —haze bank at S
	2 p. m.	76	30.08	N—NE	light	NW	..
	6	75	30.04	ENE—E	..	..	..
	10	70	30.01	S	..	..	.. —rain in the night
" 9..	6 a. m.	70	29.88	SSW—NW	moderate	{ WSW } { WNW } { SSW } brisk	cloudy—wind NW at 8—clouds WSW NW
	10	71	29.90	NW—N	fresh	{ W by S } { NW—W—NNE }	fair
	2 p. m.	72	29.92	NNW	..	{ W by S } { NNE }	..
	6	70	29.95	N	moderate	..	..
	10	66	30.00	..	light	..	..
" 10..	6 a. m.	60	30.10	..	..	..	..
	10	64	30.12	NW	..	..	..
	2 p. m.	77	30.11	NW—SSW	..	{ W by S } { NW }	..
	6	70	30.10	SSW	..	..	..
	10	66	30.11	..	..	..	..
" 11..	6 a. m.	66	30.10	SW by W	..	W by S	..
	10	72	30.11	..—SSW	moderate	{ .. } { S }	..
	2 p. m.	78	30.10	SSE	..	{ .. } { SSE }	..
	6	73	30.06	..	..	..	..
	10	68	30.06	..	..	..	.. —bank at W
" 12..	6 a. m.	70	29.97	..	..	WSW	cloudy

CITY OF NEW-YORK—CONTINUED.

<i>Date.</i>	<i>Hours.</i>	<i>Ther- mometr.</i>	<i>Barome- ter.</i>	<i>Winds.</i>	<i>Strength of Wind.</i>	<i>Clouds from what direction.</i>	<i>Weather.</i>
August 12..	10 a. m.	75	29.99	s by e	fresh	{ WSW SSW }	cloudy
	2 p. m.	82	29.90	..	strong	{ WSW S }	fair
	6	78	29.84	..	moderate	..	—cloudy at w
" 13..	20	75	29.80	..	..	SSW	cloud
	6 a. m.	76	29.70	SW	moderate	SW	fair
	10	83	29.72	..	..	WSW	..
" 14..	2 p. m.	85	29.70	WSW	..	..	..
	6	82	29.71	..	..	..	..
	10	75	29.78	..	..	..	clear
" 15..	6 a. m.	69	29.82	WSW—WNW	..	NW	fair
	10	76	29.90	WNW	..	WNW	..
	2 p. m.	83	29.88	WSW—WNW	..	w by s	..
" 16..	6	79	29.88	WNW	light	..	clear
	10	72	29.90	SSW	..	..	..
	6 a. m.	70	29.88	S—SSE	faint	WSW	fair
" 17..	10	78	29.90	SSE—ENE	light	SW	..
	2 p. m.	83	29.89	..	..	WSW	—cloudy
	6	77	29.88	ESE—W	..	..	cloudy and thunder—rain at 8 o'clock
" 18..	10	68	29.90	W	fresh	..	rain
	6 a. m.	70	29.93	ENE—SSW	light	..	cloudy
	10	74	29.96	S—SSE	moderate	{ WSW SSW }	..
" 19..	2 p. m.	81	29.96	SSE—SE	..	{ WSW SE—ESE }	fair
	6	76	29.97	NW	..	WSW	thunder shower
	10	65	30.00	N	..	..	cloudy
" 20..	6 a. m.	66	30.00	..	light	{ sw by w NW }	..
	10	76	30.00	..	..	{ sw by w NNE }	fair
	2 p. m.	83	30.00	N—NNW	moderate	NW	..
" 21..	6	76	30.00	N	..	..	..
	10	68	30.01	..	light	..	clear
	6 a. m.	65	30.02	NW	moderate	..	..
" 22..	10	72	30.04	..	..	NNW	fair
	2 p. m.	75	30.00	NNW	fresh	NW	..
	6	73	30.01	NNE	..	..	clear
" 23..	10	63	30.06	NW	moderate	..	..
	6 a. m.	62	30.11	NNW	..	..	..
	10	70	30.15	SW	moderate	NNW	fair
" 24..	2 p. m.	78	30.11	NW	light	..	..
	6	75	30.10	NW—E	faint	..	..
	10	71	30.11	..	light	..	..
" 25..	6 a. m.	65	30.15	N	fresh	..	..
	10	70	30.17	NNE	..	..	..
	2 p. m.	78	30.19	S	..	..	..
" 26..	6	73	30.19	SE	..	..	..
	10	69	30.19	..	..	..	..
	6 a. m.	65	30.19	NNE	moderate	S	..
" 27..	10	70	30.19	..	..	SE	..
	2 p. m.	75	30.15	SE	..	..	cloudy
	6	69	30.13	..	..	..	..
" 28..	10	65	30.10	..	fresh	..	..
	6 a. m.	63	30.05	..	moderate	S	..
	10	70	30.01	NNE	light	..	..
" 29..	2 p. m.	81	30.00	S	..	..	..
	6	78	29.98	..	..	SW	—hazy
	10	72	29.97	NE	..	..	.. at s
" 30..	6 a. m.	70	29.90	..	fresh	{ SW ENE }	—foggy
	10	72	29.95	..	..	..	..
	2 p. m.	74	29.98	..	..	..	..
" 31..	6	68	30.00	..	..	..	..
	10	67	30.03	..	..	..	fair
	6 a. m.	61	30.15	..	moderate	..	clear
" 32..	10	68	30.17	NNE	..	..	..
	2 p. m.	73	30.18	NE—E	light	..	..
	6	68	30.18	SE	..	..	..
" 33..	10	65	30.18	..	..	..	..
	6 a. m.	66	30.18	SW	..	..	..
	10	74	30.18	..	moderate	..	..
" 34..	2 p. m.	78	30.10	SW to W	..	WSW	fair
	6	74	30.08	..	light	..	..
	10	70	30.08	..	..	..	..